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STAR BOBBINS FOR SEWING COTTON AND THREAD.

THE illustrations given herewith represent several varieties of a novel form of bobbin for sewing cotton, thread, silk, and a general view of the machine employed for winding the material on these bobbins. Fig. 1 is a view of important details of the winding mechanism. The improved bobbins consist of thin card disks, so slotted as to give them the appearance of stars, with curved shooting rays, into and from which the fibers can be wound and unwound.

To the general public probably nothing could appear simpler and more effective than the old-fashioned wooden bobbin, but in the trade this bobbin is said to impart imperfections to the material wound upon it. One of the principal of these is that the thread becomes moulded, as it were, into square section, thus eventually causing a rupture of the fibers forming the corners of the square, in passing through the eye of a needle, and also, in a smaller degree, by abrasion with other surfaces, as in sewing hard stuffs. The pearly appearance, too, of unglazed threads is necessarily lost in the square crushed samples. There are numerous forms of cards employed for the retailing of threads, silks, and wools, which are free from the defect above stated, but there are none, with the exception of those forming the subject of this article, which revolve and pay out the material in the same continuous manner as an ordinary bobbin.

The new disk bobbins promise to supersede the old wooden bobbins, particularly for export purposes, on account of the great difference in weight in favor of the former, twelve of which weigh only ½ oz., as against 5 oz. for twelve ordinary bobbins, each holding a similar amount of thread. This is an advantage which cannot fail to be appreciated, since the weight of the bobbins in some Eastern countries counts as the dutiable material. Moreover, for the trade in fancy silks, worsteds, etc., the disks appeal largely to the eye. For instance, on the ordinary wooden reel only a cylinder of closely packed fibers resembling a solid block is seen, whereas material wound on disks has a soft fluffy appearance, and the interlacing of the threads woven in and out of the slits in the cards displays the material to a degree which is "taking" to the eye.

In the samples of cards sent us the preference would be at once given to the ropy-looking pattern that covers a disk with narrow slits, and through which the threads are woven in and out without missing any one of the openings. This is known as "single winding," and it is easy to perceive that the material so wound is shown to its fullest advantage, and that the voluminous appearance is accentuated on the large cards with very narrow slits. This form of disk is extremely attractive in the retail trade. On the contrary, the "double winding" system, which is a more recent introduction to obtain a very great quantity of thread in the least space possible, is far less showy. In the latter the rays are extremely slender, and the gaps between very wide, the consequence of which is that the wound material "balls" out to a great thickness. The quantity of thread contained on a 2 in. disk of this kind is 300 yards. On the narrower slitted disks the pattern formed by the threads in crossing is more distinctly visible as that of a star. With the large slits it becomes a ball.

These disks are the invention of Mr. John Keats, and are manufactured by Mr. R. Trierenberg, of Vienna. The industry is a special one, with a capacity at present of 3,000,000 disks per week, which production is to be doubled by new machinery now being laid down. Each stamping machine turns out an average of 50,000 disks per day. They are made entirely from wood, pulped and treated by a chemical process to toughen them. The disks, as manufactured, require a constant supply of wood, to obtain which 20,000 acres of forest land are rented in certain mountainous districts of Hungary, Upper Austria, and Styria exclusively for this purpose. The disks are now made of the lightest possible form, two of them of 2 in. diameter being only 1 mm. thick. The first disks made were coated in batches with colored varnishes after being stamped out. This operation was found to be expensive, and is now replaced by the process of coating the pulp boards entire with a kind of water color, and, when dry, polishing them to a hard glossy surface with agate stones. The disks are then stamped out to the various patterns.

The machines employed for winding the material on the cards call for special notice. They are made by a firm at Lille, North France—formerly Messrs. Greenwood & Batley, but now Messrs. Batley & Keats. Our illustration is from a photograph, and represents the latest type of machine used for double winding. Another and simpler machine is in use for single winding, the main difference between the two systems being that in single winding the point from which the thread is thrown—from an os-

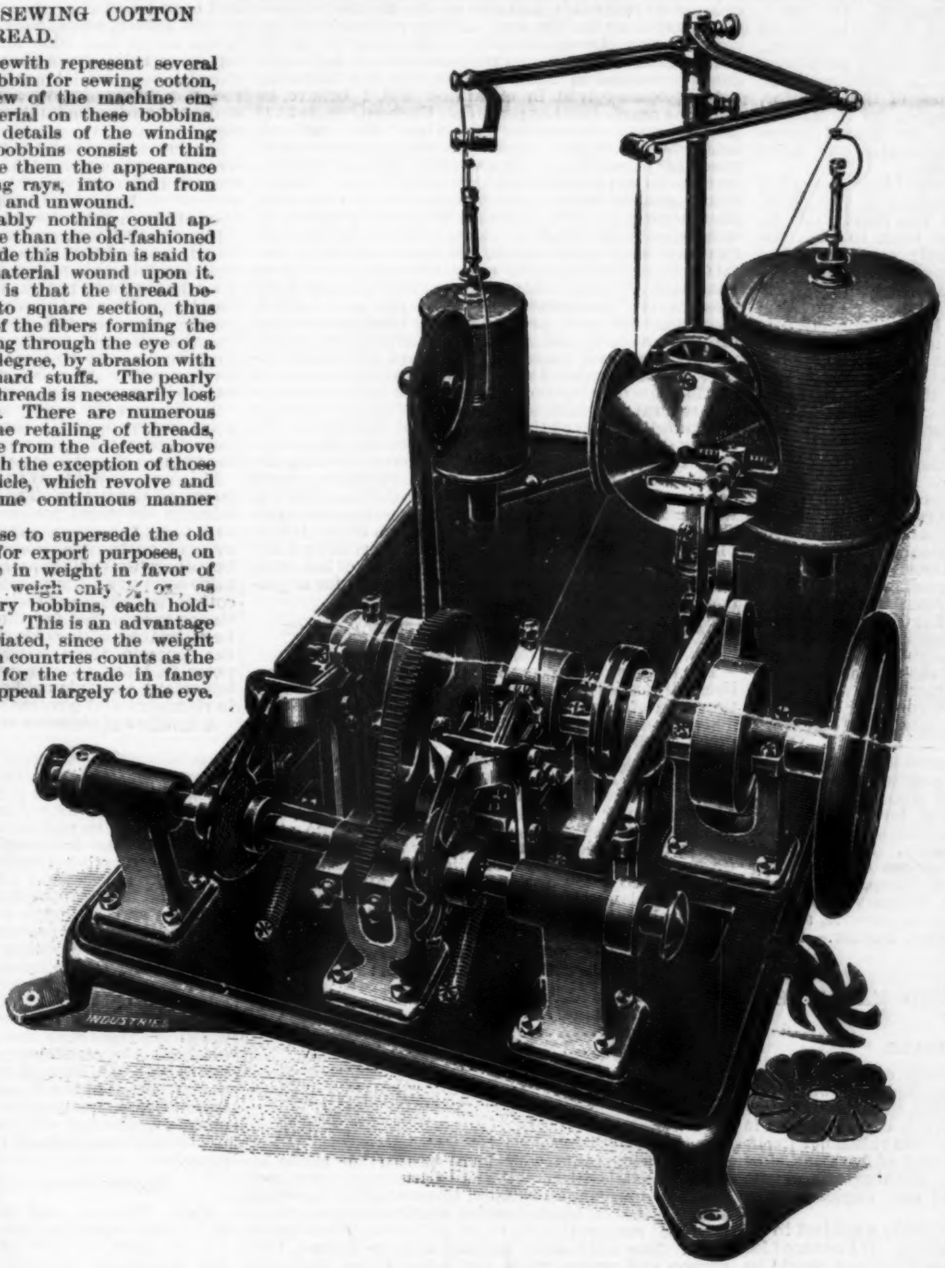


FIG. 5.—MACHINE FOR WINDING STAR BOBBINS.

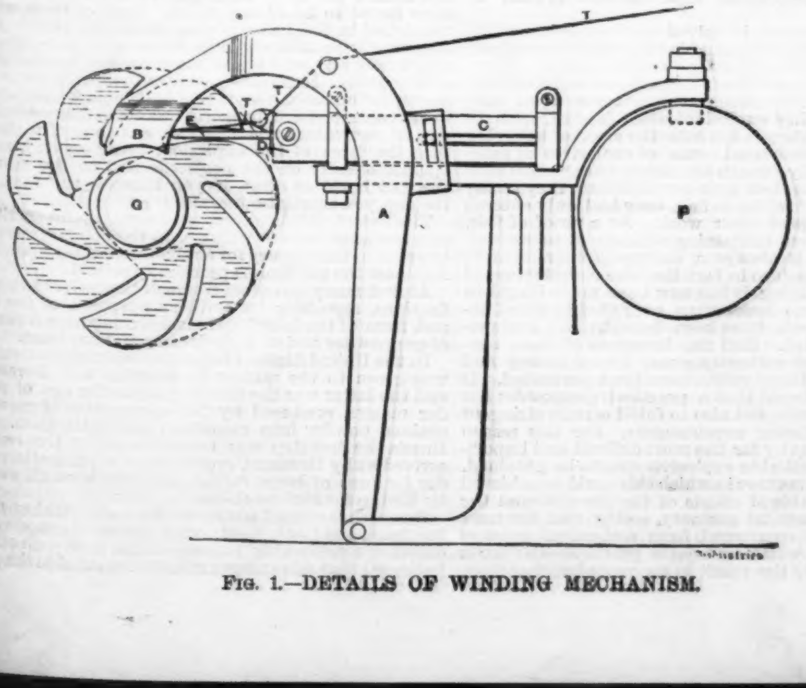
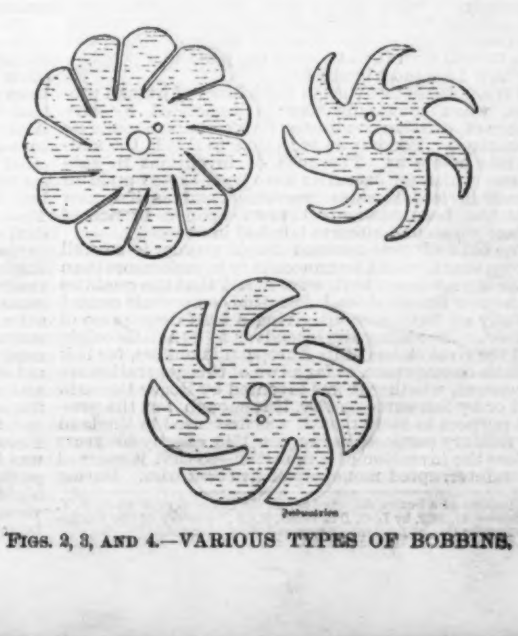


FIG. 1.—DETAILS OF WINDING MECHANISM.



FIGS. 2, 3, AND 4.—VARIOUS TYPES OF BOBBINS.

cillating lever across to the disk—is fixed, whereas in the double winding machine the beauty of the results depends on a *sliding* point which has to pass within the circumference of the disks at the commencement of the winding and to gradually retreat in the exact proportion to the filling up of the disks. The cards are run at a continuous speed of 1,000 to 1,500 revolutions per minute, and the sliding point above mentioned, which is really a needle, has to pass once through every alternate slit by a to-and-fro movement; the result is that the thread only leaves the guiding eye of the needle at the exact spot where it is to be laid, and the threads are thus placed one upon the other in regular layers.

To obtain this retreating movement of the oscillating needle, a curved lever, A (Fig. 1), with one end shaped like a saddle, B, and fulcrumed as shown, rides on the surface of the outer layers of threads, which, as they increase, naturally force the lever up and backward. The vertical portion of this lever is forked, and the horizontal needle lever, C, with its sliding chuck, D, oscillates in between it. The lever, A, in retreating, carries back with it the laying on needle, E, until finally, at the finish of the winding, the needle stands just clear of the disk's periphery. The thread, TTT, is drawn from the ordinary large spooling bobbins, placed at the rear of the machine, and adjusted to any desired tension by a feather-weight tension flier, from which the thread passes over the pulley of the counting apparatus and down to the oscillating lever and its needle.

The various movements are obtained by two shafts; the rear one carrying the belt pulleys and two cams, F, oscillating the levers, C, and the front shaft, G, driven by change pinions from the back to turn the disks. The counter, which is entirely new, fulfills the requirements of measuring any length of thread from 10 to upward of 500 yards by means of a quickly adjusted apparatus. The counter always resets itself automatically to the given length by its connection to the hand lever for starting the machine. At the end of the counted length of thread the machine stops instantaneously by an automatic arrangement. An older form of counter cuts the thread so that the needle has to be threaded again for every disk put on. As it is now, the thread is cut between the needle and the disk by the operator, the disk is quickly replaced by another, and the loose end of the thread is simply given a turn or two in the arms ready for starting. Notwithstanding the attention necessary to place the cards, one machine with two heads running at 1,500 revolutions per minute produces about 50 per cent. more wound material than an ordinary wood spooling machine running at 2,000 revolutions per minute. It should be remembered that the speed of winding on a wooden bobbin varies very little from the commencement to the finish, whereas with flat disks the increase of lineal speed of the threads is augmented very considerably toward the finish, although the same speed of rotation is maintained. This takes place more particularly on the narrow slitted patterns of cards. The production is equal to about 12,000 yards per hour with one machine, but an industrious attendant can work three machines—*i. e.*, six heads.

Within the last few months the card stamping branch of the industry has introduced a case to contain these disks in the form of a double shell wood pulp stamping. The two halves, when closed, form an axis, on which the disk revolves freely, the thread passing out through a small slit in the periphery. For the retail trade these cases possess the advantage of protecting the threads from dust, light, and damp, and can be used on a sewing machine, or for ordinary hand sewing. They are colored, giving the appearance, according to the color, of kid or Russian leather.—*Industries.*

SMOKELESS POWDER AND MAGAZINE RIFLES.*

By L. G. DUFF GRANT.

FEW subjects have attracted more attention during the last few years than that of smokeless powder, one reason of this being, I have no doubt, that there are few subjects of such universal interest, embracing as it does not only the manufacture of the substance itself, but the whole machinery and theory of fire arms, shot guns, rifles, and artillery, to say nothing of the vast uses it can be put to in mining and engineering in general.

The matter before us is far too wide a subject to be dealt with in a single paper or lecture. If I lectured for a whole week on the subject, I am sure there would be one-half still left unsaid. To-night I purpose first just to glance at the reign of black powder and at the causes that have led to its overthrow, for there is no doubt that the days of Shakespeare's "villainous saltpeter" are numbered, then to touch lightly on the weapons now being mostly used with smokeless powder, especially for military purposes, and on the various smokeless or rather nitro-powders now in existence and then to deal with the history of the particular powders in which I am most interested.

It is a notable fact that in the history of human progress, when something new is demanded by any change of existing conditions, it is certain to make its appearance. There is no exception to this in the matter now before us. The rush of inventions in substances which for centuries have been looked upon as already perfected seems marvelous, and as if a new light had been suddenly thrown upon a branch of science which had hitherto lain hid in obscurity.

The old and time-honored black powder is so well known that it would be unnecessary to make more than a passing reference to it, were it not that the qualities of the new chemical and scientific compounds cannot be fully set forth without giving a brief description of the old. Dismissing the legends as to its Asiatic origin and the rival claims of its European inventors, for it is of little consequence, as far as we of this generation are concerned, whether it was invented by Roger Bacon in 1292 or by Schwartz in 1320, it is enough for the present purpose to state that it was first used in England for military purposes in the year 1346, exactly 500 years before the invention of gun cotton—so that it enjoyed an uninterrupted monopoly of five centuries. During the whole of that period no important improvement was made in its manufacture, except that of its granulation, this being comparatively modern and of late years carried to an extreme extent, so that black powder is now made with grains much finer than mustard seeds on the one hand and larger than walnuts on the other, with wide diversity in the shape of the greater sizes. This diversity in size and shape is intended to govern the rapidity of combustion, which becomes slower as the size is increased; and the requirements of modern artillery, strange though it may seem, demand a slower and slower rate of combustion, which in black powder is attended with a corresponding increase of smoke.

The force of all explosives is created by the sudden formation or ignition of more or less elastic gases. These while occupying marvelously small compass when confined, swell to immense proportions on being set free. An expansion to 1,500 times their previous bulk has been commonly received, but as so much of this depends on the temperature, there is great diversity of opinion on this point, and also on the amount of pressure exerted on the fire arm and the projectile, as calculated upon the square inch of the chamber of the gun. Authorities differ on the carbonic acid and oxide gases contained in black powder, but the following list of gases evolved in expansion will, I believe, be found as nearly exact as possible. Carbonic oxide 20·12 (elastic—some authorities give about 25); carbonic acid, 0·94 (non-elastic—some authorities give over four times this proportion); nitrogen, 9·98 (extremely elastic, up to violence; sulphureted hydrogen, 0·18 (non-elastic); marsh gas, hydrogen, and oxygen, in all 0·16—total gaseous products 31·38, and with 68·62 solid products by weight, gives the whole products as 100. It will thus be seen that black powders give less than one-third of useful forces, no less than over two-thirds being inert or detrimental. The advocates for the nitro-compound explosives or "smokeless," as they are now called, assert that the inert products of the black powder are instantly recondensed, and that it is greatly this which unduly heats and fouls the gun barrel and causes recoil. Black powder, I need hardly state, is a mechanical mixture of saltpeter, charred wood and sulphur, in the several proportions of say 78, 12 and 10 parts in the hundred, and of these the last is held to be the chiefly detrimental one, and therefore the one principally to be got quit of. With the above startling disproportions in the useful and useless products, sooner or later science must step in to adjust them, and the wonder is that this movement has been so long deferred. The only explanation I can give of the delay is that black powder has been so good and so reliable a servant, doing all the work hitherto required of it so well, that no change or improvement was sought for or proposed.

ATTEMPTS TO FIND A SUBSTITUTE FOR BLACK POWDER.

The task set for accomplishment was to get quit entirely, if possible, of sulphur, and to reverse the proportions of useful and detrimental products of combustion. This an Austrian chemist, Schonbein, endeavored to do by treating dry carded cotton with nitric and sulphuric acids, and in 1846 he announced his invention. Schonbein, like many pioneers in invention, only narrowly missed the mark, and to him great honor is certainly due. He had actually aimed too high. His products were only too good, too refined for the everyday work to be done in fire arms, for which certain conditions must be strictly complied with. His combustion was too quick for artillery, and after many attempts to lessen this rapidity, gun-cotton is now only used for blasting purposes.

The following table of the products by combustion of this wonderful but ungovernable explosive will explain much of its unfitness for fire arms:

Carbonic acid	33·86
Carbonic oxide	29·97
Marsh gas	4·28
Hydrogen	0·24
Nitrogen	13·16
Carbon	1·62
Vapor of water	16·87
Total	100·00

It is owing to its very large proportion of the extremely elastic nitrogen that gun-cotton possesses such rending powers, nearly equal to one-half of the whole elastic forces of black powder, and it is this very richness that renders this explosive quite unsuitable for fire arms. The only solid product appears to be a little carbon and water, while the latter, being converted suddenly into a highly elastic vapor forming nearly 17·100 of the whole, may add considerably to what the French appropriately term "la force brutale" of the explosion.

The next problem to be solved was how to bring this undoubtedly otherwise valuable force as obtained from a nitro compound explosive under due control.

Chemists working in their laboratories and knowing the effect of certain chemical substances upon each other in producing explosion when ignited, seem to have unaccountably fallen into the error of believing that they had discovered forms of explosives of practical use. Readily enough obtaining an explosive mixture and fancying their task accomplished, they rashly cried "Eureka!" while, in fact, they had only entered on the first stage of their work. As a proof of this, take the explosives containing chlorate of potassium. This substance is always a dangerous ingredient to deal with, so much so in fact that the manufacture of explosives containing it has now been made illegal in England. Yet no fewer than over 80 chlorate of potassium compounds have been brought out and presumably patented. Had the inventors of these consulted any sound authority, great loss of money and much disappointment might have been prevented. It must be remembered that a practical gunpowder has not only to explode, but also to fulfill certain stringent and widely differing requirements. For this reason the next step was by far the most difficult and important, if a truly reliable explosive was to be obtained. The most likely manner in which this could be achieved was by the combined efforts of the chemist and the proficient in practical gunnery, seeing that the most highly scientific compound, from a chemical point of view, might be worthless from a practical—the latter being apparently the result in an overwhelming number of cases; and as will be seen, the practical introduction and ultimately victorious advocacy of these new explosives are to be attributed to a Scotch gunmaker, who had unusual facilities for dealing with them.

Many of you, I have no doubt, know to whom I refer, for I believe that the name of the late Mr. J. D. Dougall, senior of the firm of J. D. Dougall & Son, gun and rifle manufacturers, of London and Glasgow, is almost as well known on this side of the "herring pond" as on the other. A few years ago in England "Dougall" guns were all the rage; it was not an uncommon thing in the sporting field, when a man was not distinguishing himself with good shooting, to hear the remark, "You ought to get a Dougall."

It was about the year 1865 that the invention of Capt. Schultze, an officer in the German army, who afterward distinguished himself in the Franco-Prussian war, was brought to Mr. Dougall's notice. Had it not been so, probably Capt. Schultze and his invention would have returned to the "Fatherland" and been heard of no more, and Schultze powder, now so well known, would have ceased to exist. Of course, it was not at that time an ideal or perfect explosive, but in such hands as those of Capt. Schultze, a born chemist, and Mr. Dougall, than whom no one possessed a higher knowledge on questions of gunnery and gunpowder, its improvement was only a matter of time.

We have seen that while the old black powder was a mechanical mixture of three ingredients, with a narrow range in quality but with great stability, and that gun-cotton was a highly scientific chemical but uncertain product, some happy medium had to be found if any genuine improvement was to be made. Logically, it might have been said: We have only to combine the two things and to make a powder partly of a mechanical and partly of a chemical mixture or combination. This in the abstract would have been reasonable enough, and, in fact, contains much truth; but the difficulty was how to accomplish it, and this was the task which Capt. Schultze and Mr. Dougall set themselves to solve, and right well they carried out their programme, as has since been proved.

To discover the happy medium referred to, the main point was to diminish the volume of nitrogen in gun-cotton—that being the rending force—and to retain the volume of carbonic acid in black powder.

If it were possible at the same time to increase the latter, all the better. That seemed simple enough considering the great resources of modern chemical science; but the overwhelming number of failures consequent on the required conditions has proved it to be otherwise. The process in the manufacture of nitro-compound gunpowder starts upon that of gun-cotton, but the great distinction is that after the substance substituted for the black powder charcoal has been treated with acids, it is saturated with salts in the concrete, these being the equivalent of the saltpeter in black powder, and it is thus that the all-important carbonic acid and other gases are produced in regulated and governable quantities.

A number of chemists were known at that time to be at work to improve upon gun-cotton, but the first trace of anything tangible being done is noted in the *Journal of the Royal United Service Institution* of 1868, which contained a lecture on nitro-compounds by Mr. Dougall, with Admiral Nicolson in the chair, and referring in particular to the invention of Capt. Schultze. That lecture shows that Mr. Dougall had, some ten years previously, published an opinion that we were on the eve of some great invention in explosives, and being an author of repute and sound judgment on such subjects, he was naturally sought out by inventors of improvements in firearms and explosives. He was met with a storm of opposition on every side, but Mr. Dougall stood manfully to his guns, and lived to see the great revolution in explosives virtually accomplished.

The nitro-powder invented by Captain Schultze for sporting purposes or shot guns culminated only in the production of smokeless powder for military purposes, for in 1879 Mr. Dougall succeeded in drawing the serious attention of the French government to the advantages of smokeless powder for sporting guns, and French chemists, who are well known as clever inventors and improvers, soon learned to employ it for military purposes.

BROWN PRISMATIC OR COCOA POWDERS.

Capt. Schultze and Mr. Dougall, having led the way with sporting powders, other chemists than French soon followed in their footsteps, resulting in the numerous nitro-compounds which have since sprung into existence, though I may add many of them only existed to die the death they merited, as less than 5 per cent. when put to the practical test were found to be of any value. Most of them when "weighed in the balance were found wanting." For adapting it to military rifles there were many obstacles in the way, and one of these applied to all classes of fire arms. It seemed a contradiction in terms to assert, for instance, that a rifle ball could be propelled to an enormous and formerly unknown distance without an equivalent recoil. That was to say, in effect, that the force of the explosion, being general, must operate equally on the projectile and on the rear of the gun itself, so that, if you increase the force on the one, you must also increase it on the other.

The notoriously heavy recoil of certain military rifles, and the jamming of cartridges in the Soudan, gave an impetus to the inquiry for a reliable smokeless powder. And now the problem is practically settled.

At first many inventors confined themselves to modifications, especially for artillery purposes, of the size and form of the individual masses composing a charge of gunpowder and of their density and hardness.

In the United States, I believe, considerable attention was given to the matter by Rodman and Doremus, and the latter was the first to propose the use of powder masses, produced by the compression of coarsely grained powder into moulds of prismatic form. In Russia the first step was taken to utilize the results arrived at by Doremus, and to adopt a prismatic powder for guns of large caliber, and very soon afterward by Krupp for his breech-loading guns.

Researches carried out by Sir Frederick Abel, of English fame, and Capt. Noble, with a series of gunpowders differing considerably in composition from each other, indicated that advantages might be secured in the pro-

* Reports of a lecture delivered before the United Service Club, N. Y. December 17, 1892, by L. G. Duff Grant, F.I.S., Secretary of the Smokeless Powder Co., of London.—*Army and Navy Journal.*

duction of powders for heavy guns by so modifying the proportions of the constituents as to give rise to the production of a much greater volume of gas, and at the same time to diminish the heat developed by the explosion. These researches also served to throw considerable light upon the cause of the wearing or erosive action of powder explosions upon the inner surface of the gun, which in time, and especially in large guns, produces so serious a deterioration of the arm as to diminish the velocity of projection considerably, and to affect the accuracy of shooting. Several causes undoubtedly combine to bring about the wearing away of the gun's bore, which is especially great where the products of explosion, while under the maximum pressure, can escape between the projectile and the bore of the gun. A series of careful experiments made by Capt. Noble with powders of different composition and with other explosives afforded decisive evidence that the material which furnished the largest proportion of gaseous products, and the explosion of which was attended by the developments of the smallest amount of heat, exerted least erosive action.

It is probable that important changes in the composition of powders manufactured in England for heavy guns would have resulted from those researches, but in the meantime two eminent German gunpowder manufacturers had occupied themselves independently and simultaneously with the question of producing some more suitable powder for heavy guns than the various new forms of ordinary black powder, the rate of burning of which was, after all, reduced only in a moderate degree by the increase in the size of the masses and by such increase in their density as it was practicable to attain. They directed their attention, not merely to an alteration of the proportion of the powder ingredients, but also to a modification in the character of charcoal employed, and the success attending their labors in these directions led to the practically simultaneous production of a prismatic powder of cocoa-brown color, consisting of saltpeter in somewhat higher proportion, of sulphur in much lower proportion, than in normal black powder, and of a very slightly burned charcoal. These brown prismatic powders, or "cocoa powders," as they were termed from their color, are distinguished from black powder by their very slow combustion in open air, by their comparatively gradual and long-sustained action when used in guns, and by the simple character of their products of explosion as compared with those of black powder. Although the smoke produced upon firing a charge of brown powder from a gun appears at first but little different in denseness to that of black powder, it certainly disperses much more rapidly. This class of powder was substituted with considerable advantage for black powder in guns of comparatively large caliber, nevertheless it became desirable to attain even slower or more gradual action in the case of the very large charges required for guns of the heaviest calibers, such as those which propel shot of about 2,000 lb. weight. But these powders were soon found to be only a midway haven between black and smokeless or practically smokeless, and are rapidly being superseded. In naval service, more especially for the defense of ships against attack by torpedo boats, a smokeless powder has come to be an absolute necessity, as after a very brief use of the machine and quick-firing guns with black powder, the objects against which their fire is destined to operate become more or less completely hidden from those directing them, by the dense veil of powder smoke produced.

The properties of ammonium nitrate, of which the products of decomposition by heat are, in addition to water vapor, entirely gaseous, have rendered it a tempting material to work upon in the hands of those who have striven to produce a smokeless powder, but its deliquescent character has been the chief obstacle to its application as a component of an explosive agent susceptible of substitution for black powder for service purposes. A German chemist and engineer named Gaus conceived that by incorporating charcoal and saltpeter with a particular proportion of ammonium nitrate he had produced an explosive material which did not partake of the hygroscopic character common to other such mixtures, and that by its explosion the potassium in the saltpeter formed a volatile combination, a potassium amide, so that although containing nearly half its weight of potassium salt, it would furnish only volatile products. The views of Mr. Gaus regarding the changes which his so-called "amide" powder undergoes upon explosion were not borne out by existing chemical knowledge.

OTHER NITRATE COMPOUND GUNPOWDERS.

Remarkable results were also stated to have been obtained in France with a powder of the ammonium nitrate class for use with the magazine rifle (the Lebel) which was being adapted to military service in that country. It is now well known, however, that more than one smokeless explosive has succeeded the original powder, and that the material now adapted for use in the Lebel rifle bears, at any rate, great similarity to preparations which have been made the subject of patents in England, Germany, and elsewhere. If there is still ammonium nitrate left in the French smokeless powder adopted for use in the Lebel magazine rifle, the longer they put off their next "brush" with their Germanic neighbor the better for them.

Their original powder also, I believe, contained picric acid (the basis of "melinite"), a substance extensively used as a dye, and obtained by the action of nitric acid at a low temperature upon carbolic acid and cresylic acid, constituents of coal tar, one of the earliest known explosives of organic origin, and one of the most dangerous to deal with. With a powder in which picric acid forms a part, I think, I would almost as soon stand in front of the guns when fired as behind. If picric acid was not present in the French powder for rifle purposes, it certainly was in the powder they adopted for filling shells and commonly known as "melinite," invented by M. Turpin.

Of the violence with which picric acid will explode an example was given on the occasion of a fire at some chemical works near Manchester a few years ago. The shock was felt over a distance of two miles from the seat of the explosion and the sound was heard for a distance of 20 miles.

Soon after the discovery of gun-cotton by Schonbein and Bottger in 1846, endeavors were made to apply gun-cotton wool rammed into cases as a charge for small arms, but with disastrous results. Subsequently Von Lenk, who made the first practical approach to the regulation of the explosive power of gun-cotton, produced small arm cartridges by superposing layers of gun-cotton threads, these being closely plated round a core of wood. So far as mere smokelessness is concerned no material can surpass gun-cotton, pure and simple; but, even if its rate of combustion in a firearm could be controlled with certainty and uniformity, although only used in very small charges, such as are required for military rifles, its application as a safe and reliable propulsive agent for military and naval use is attended by so many difficulties that the non-success of the numerous attempts made to apply it in this direction is not surprising. Various substitutes can be used, and as each has its own advocate, it is only necessary to state that they must consist of some pure vegetable fiber.

Sir Frederick Abel invented a system of preparing gun-cotton, which was no sooner elaborated than its application to the production of smokeless cartridges for sporting purposes was achieved with a fair amount of success by Messrs. Prentice, of Stowmarket. The first gun-cotton cartridge which found considerable favor with sportsmen consisted of a roll of felt-like paper, composed of gun-cotton and ordinary cotton, and produced from a mixture of the pulped materials. Afterward a cylindrical pellet of slightly compressed gun-cotton pulp was used, the rapidity of explosion of which was retarded by its impregnation with a small proportion of India rubber. Neither of these cartridges possessed sufficient uniformity of action to fulfill military requirements, but after a series of experiments which Sir Frederick Abel made with compressed gun-cotton arranged in various ways, very promising results were attained, and ended in the production of what is now known as "E. C." sporting powder, one of the best sporting powders now in the market, and later still to the production of what was called the Johnson and Borland powder. The latter, however, was short lived, as it did not come up to the expectations of the inventors, and was found to be far inferior to E. C. Of both E. C. and the Johnson and Borland powders gun-cotton or nitro-cotton is the basis, and in these I believe both camphor and liquid solvents are used to harden the powder granules, with a view to render them non-porous. I believe a chemist of the name of Rabelais, with probably practical knowledge and serious purpose, was the first to suggest camphor as an ingredient.

Another inventor, of the name of Hengst, made a powder from straw prepared and chemically treated, and finally manufactured into a gunpowder granular in form, but it seems to have died a natural death, the difficulty being to get uniformity with a basis such as straw, which in itself varies so much, the joints requiring very different nitrification from the rest of the stalk.

In Germany, the subject of smokeless powder for small arms and artillery was steadily pursued in secret, and a small arms powder giving excellent results in regard to ballistic properties and uniformity was elaborated at the Government Powder Works, and appears to have been adopted into the German service for a time, but its first great promise of success seems to have failed of fulfillment through defects in stability.

Experiments were also carried out on a large scale with various nitro-glycerine powders produced at Woolwich, in England, and the Wetteren Powder Company, in Belgium, also manufactured so-called paper powders of the same kind, and their efforts have been attended with considerable success.

Nobel's smokeless powder, made up of nitro-glycerine, nitro-cotton and camphor, also gave good results, but it was feared that the presence of so volatile an ingredient as camphor would surely set up a chemical change, and that the powder would not be reliable in all climates. Sir Frederick Abel's cordite or string powder, if such a term can be used, was exposed to a very high and a very low temperature, without being injuriously affected either as regards pressure or velocity, and the accuracy from the machine rest at 1,000 yards was nearly equal to that given by Nobel's, the deviation being a little over one foot; but the excessive heat generated caused metallic fouling, and frequently the covering of the bullet was stripped off and remained in the barrel, rendering the rifle unserviceable. It was seen that some change was necessary, either in the explosive or the bullet, to overcome these serious defects.

Various descriptions of bullets, including one of solid copper lubricated in different ways, were tried, but the results have not been wholly satisfactory; soft steel and wrought iron were tried as coverings for the bullet instead of nickel, and some slight change was made in the powder. It was found possible to get over the metallic fouling, but the shooting fell off and was not up to that obtained either with the original black powder pellets or with Nobel's powder.

Further changes have since been made in its composition, but it is an open secret that it is not giving the satisfaction anticipated. Probably its greatest fault is the enormous amount of heat generated, so much so that I believe that after firing 50 shots in rapid succession from the magazine rifle the barrel becomes so hot that the sights melt and drop off—about the most serious defect a powder could have, and a defect which I believe is impossible to remedy as long as gun-cotton and nitro-glycerine form the basis.

It is called "cordite" from its string-looking appearance, being made by dissolving gun-cotton in a solvent and forcing the compound through perforated dies by which it is shaped into threads and strips. Notwithstanding all its defects, this is the powder which is being adopted in England by the British government for use in their new magazine rifle which is destined to replace sooner or later the Martini-Henry with which the troops are now armed. This has been entirely brought about by the influence of Sir Frederick Abel, who, like many another inventor, speaking of his own baby, says: "With all thy faults, I love thee most."

Had I time I might go on to mention the names of a host of other inventors and other products such as Engel, Glasci, Turpin, Nobel, Prof. Dewar, Emmens, Maxim, Mayer, Smerling, and many others, but those I have already mentioned are the most important, best known, and on the whole have been attended with a fair amount of success.

MISCONCEPTIONS CONCERNING SMOKELESS POWDERS.

Much misconception has been created by classing nitro-compound gunpowders for firearms with "high explosives." They are the very reverse, and should be called "low explosives" if any qualifying term be applied to them at all. Their whole purpose and action are comparative slowness and mildness in use, as I shall show you by and by, in accordance with the requirements of modern firearms, while, if kindled otherwise than when confined in a gun and ignited by a percussion cap, they do not explode at all, but merely deflagrate. "Deflagration" differs from "explosion" in that while there is a rapid combustion there is no such sudden or violent outburst as follows the ignition of most explosives, so that there is no injurious effect upon neighboring matter not in actual contact with the conflagration. For these reasons such explosives are remarkably safe in storage and transit—a fact which is gradually but certainly becoming apparent to all who have to use them. The manufacture is also remarkably free from danger, the whole process up to the final drying and packing dealing with wet substance. It is exceedingly improbable that any modification of really "high" explosives or of their principal ingredients can ever be utilized for firearms.

I have also often seen mention made in newspapers of nitro-powders being noiseless as well as smokeless. The thing is, of course, an impossibility, and it is hardly necessary for me to say so. The fact is there is scarcely any difference between the report of the new smokeless and of black powder, except that the former is sharper and more ringing, but not of such long duration. Some four years ago, when Sir Augustus Harris, of Drury Lane fame, was performing a piece called "The Armada," there was great complaint of the theater being rendered most uncomfortable by the fumes and smoke from the black powder which was being used on the stage. His manager came to me and asked if I could help him. I went with him to an underground cellar where we had a large quantity of ammunition and various rifles stored. After extracting the bullets and wads, I fired a few cartridges, but found, to his regret, there was no noise as well as no smoke. The bullets and wads which form the resistance to the gases being removed, the powder, though ignited by a cap, merely deflagrated without explosion. We worked for a considerable time to obtain a suitable cartridge for blank firing, and also applied to several cartridge makers, but without success. Quite recently our chemist invented a blank cartridge which gets over the difficulty, so that without either bullet or wad a sharp report is obtained for blank firing and royal or presidential salutes.

Another objection often raised to smokeless powders is the vile odor and fumes that sometimes arise from them. An amusing incident was told me some time ago by an eye witness of a series of trials which were carried out near St. Petersburg, where a review was held at which the Czar was present. When he appeared on the scene the usual volley was fired by a whole regiment, the result being that the men were so overcome by the fumes and smell that every man Jack along the line commenced to vomit, a pretty reception for his Imperial Majesty! This, of course, only applies to very few powders. Many of them, on the contrary, have a most pleasant odor, and among these are the manufactures of the Smokeless Powder Company, of London.

Thus far I have dealt with the subject of smokeless powder for sporting and military purposes, and now I must glance briefly at the various compounds that have recently been introduced for mining and blasting operations, most of them smokeless or semi-smokeless, and some of them also flameless or practically flameless. Their name is legion, and I can only, therefore, touch upon a few of the most important. In this list is Dynamite Lithofracteur, Blasting Gelatine, Gelatine Dynamite, Gelignite, Roburite, Securite, Bellite, Carbo-dynamite, Von Dahmen's Safety Dynamite, Hengstite, Cotton Powder, Tonite, Potentite, and Melinite, and last, but not least, Smokeless S. B.

The dangers arising from the use of ordinary blasting powder in fiery coal mines no doubt gave rise to this endless list. Attempts had been made from time to time to provide a substitute for powder, as well as means of using such substitutes, which would secure immunity from the danger due to the presence of coal dust and fire damp, but until recently no such desirable blasting agent was forthcoming.

Some of those mentioned in the list, however, claim to answer the purpose, but I should think that it was only to a limited extent. Among these are Roburite, Carbonite, and Securite.

The inventors allow that a spark is given off on their explosion, but they say it is not a spark *per se* that will explode inflammable gases and dust. In any case they are safe explosives to use as compared with dynamite and others of the nitro-glycerine class, whose use is always attended with considerable danger. Miners will not understand that they cannot with impunity warm dynamite cartridges in frying pans over their kitchen fires or put them to dry in the oven with all the *insouciance* with which they place their Sunday dinner in the same place. So much for blasting compounds.

(*To be continued.*)

TESTS OF WIRE AND CUT NAILS.

A SHORT time ago it was announced that a test of comparative merits of cut nails and wire nails would be made at the Watertown Arsenal, Mass. The first information relative to this test states that recently quite a number of gentlemen connected with the trade saw the test made. The nails used were selected from market stocks, those of the wire being of corresponding size with the cut nails, both in weight and length, and every detail of the contest was conducted by the committee so as to be recognized as authoritative and absolutely fair. Major Reilly, the commandant, selected these nails and assorted them in packages, each one being weighed and recorded. The size of cut nails ranged from 1¼ inch nails, 3d fine, 764, to 6 inch spike nails, 40d and 60d, 6 to 17 to the pound. The wire nails were secured to correspond as nearly as it was possible.

The packages were made up and sealed and were tested in the order of their sizes, beginning with the 6 cut and 6 inch wire. The tests were for the purpose of demonstrating beyond all argument the relative hold-

ing power when used in ordinary building material. A spruce plank, well seasoned and free from knots, was selected and planed perfectly smooth. Into this the nails were driven, first a cut nail, then a wire nail, the depth being precisely four inches each for the six-inch sizes. Before being driven, they were weighed, and showed a difference of only two grammes, the wire weighing 214 grammes, the cut 212.

The first test upon the machine was with a wire nail, and it required 783 pounds to pull it out. Then the nippers were placed over the head of the cut nail, and on the beam of the indicator was registered 836 pounds. The second wire nail registered 673 pounds, and its equal in a cut nail 742. The third wire nail registered 675, and a cut nail of the same size 804.

The fourth nail tested was pulled out with a pressure of 594 pounds, but it required 964 pounds pressure to draw the cut nail—nearly 400 pounds more. The seventh, and by far the strongest holding nail tested, was drawn with 879 pressure, but the cut nail resisted until 1,200 pounds was put to bear upon it.

This enormous resistance was accounted for by the nails entering a knot on the inside of the plank.—*American Manufacturer.*

THE MANUFACTURE OF LIQUORS AND PRESERVES.*

By J. DE BREVANS, Chief Chemist of the Municipal Laboratory of Paris.

CHAPTER III. (*Continued.*)

Star Anise.
Anis Etoilé.

THE anise of Japan and China (Fig. 47) is always green; it has a dry fruit, star-shaped, brownish red,

FIG. 47.—STAR ANISE.

aromatic and bitter taste, odor of anise, seeds egg-shaped, smooth, reddish, containing a white and oily kernel.

Ordinary Anisette.
Anisette ordinaire.

Star anise	125 grm.
Bitter almonds, crushed	125 grm.
Florentine orris root in powder	62 grm.
Coriander	125 grm.

Contuse the materials and macerate in 4 l. 250 c. c. of alcohol (85°) for eight hours. Add 2 l. of water and distill to obtain 4 l. Add when cold a sirup prepared with 3 k. of sugar and 2 l. of distilled water. Bring up to 10 l. with water, then filter.

Anisette of Bordeaux.
Anisette de Bordeaux.

Green anise	160 grm.
Star anise	65 grm.
Coriander	15 grm.
Fennel	15 grm.
Hyson tea	30 grm.

Same treatment and same quantity of product as the preceding preparation.

Eau-de-vie d'Audaye.

Star anise	62 grm.
Coriander	85 grm.
Florentine orris (powdered)	125 grm.
Skins of six oranges.	
Alcohol (85°)	3 l. 800 c.c.
White sugar	q. s.

Macerate for eight days. Distill over a water bath without rectifying. Color with caramel.
Product: 10 l.

Cacao (*Theobroma cacao*).
Cacao.

The cacoa tree attains a height of from 10 to 40 feet; the wood is frail and light; the flowers are small, reddish, and grow directly from the trunk and the larger branches, as well as from the twigs. The fruit is a kind of bean about the size of a lemon, ovoid and elongated in form; the surface is broken up by ten longitudinal grooves.

Cacao Oil.
Huile de cacao.

Cacao	500 grm.

Heat and pulverize; then macerate for forty-eight hours with 4 l. 250 c. c. of alcohol (86°). Add 2 l. of water and distill so as to obtain 4 l. 250 c. c. of water; rectify with 2 l., so as to obtain 4 l. Add a sirup made with:

Sugar	5 k. 500 grm.
Water	2 l.

Bring up the volume to 10 l. and filter.

* Continued from page 14241, SUPPLEMENT No. 891.

Coffee.
Crême de moka.

Mocha coffee	500 grm.
Bitter almonds, crushed	100 grm.
Alcohol (85°)	4 l. 250 c. c.
White sugar	5 k. 600 grm.

Brown the coffee; grind and macerate for 24 hours

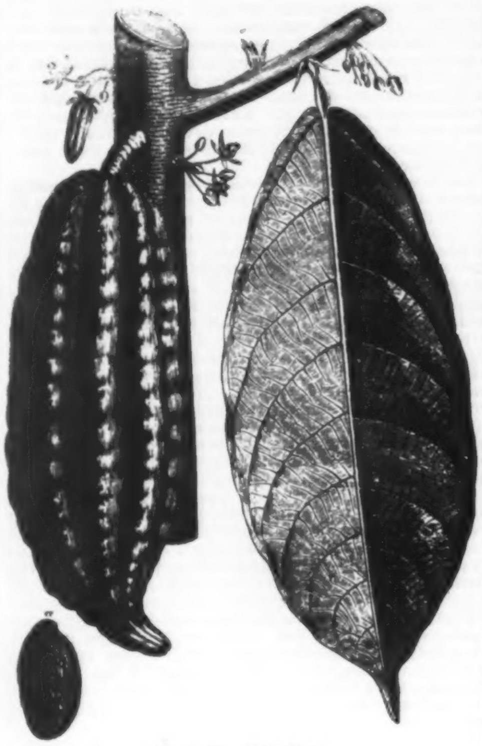


FIG. 48.—CACAO.

in the alcohol and distill. Rectify the infusion so as to obtain 4 l. and bring the volume up to 10 l.

Cinnamon (Ceylon).
Cannelle de ceylan.

This comes (Fig. 49*a*) in the form of roots of bark; color reddish yellow or fawn; agreeable taste.

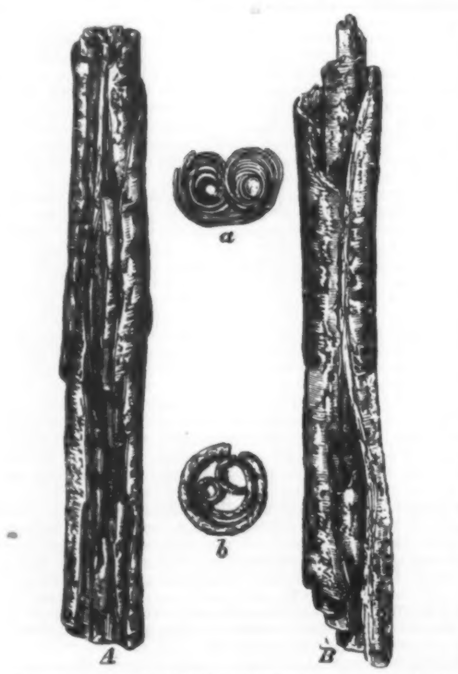


FIG. 49.—CINNAMON BARK (NATURAL SIZE.)

A, Ceylon cinnamon; *a*, transverse section; B, Chinese cinnamon; *b*, transverse section.

Chinese Cinnamon.—Bark thicker than the Ceylon cinnamon (Fig. 49 B*b*); deeper color; odor less agreeable; warm and burning taste.

Cinnamon Oil.
Huile de cannelle.

Ceylon cinnamon	80 grm.
Chinese cinnamon	25 grm.
Cloves	5 grm.

Pile up the aromatic materials and macerate for 48 hours in 85° alcohol. Add 2 l. of distilled water, and draw off 4 l of the product, to which is added a sirup, mixed cold, made from 5 k. 500 grm. of sugar and 2 l. of water. Bring up the volume to 10 l., color yellow with caramel and filter.

Oil of Cedrat.
Huile de cédrat.

Skins of 16 fresh citrons.

Macerate for 24 hours with 5 l. of alcohol at 85°. Distill with 2 l. of water, so as to obtain 5 l. of liquid. Add a sirup made according to the directions given above. Bring the volume up to 10 l. Color golden yellow with caramel and filter.

Parfait amour.

Grated skins of cedrats	62 grm.
Grated skins of lemons	31 grm.
Cloves	4 grm.
Alcohol (60°)	6 l.
White sugar	2 k. 500 grm.

Macerate for two days; distill over a water bath without rectification. Product 10 l.; color with orchil.

Celery.
Crême de célert.

Celery seed	250 grm.
Seeds of doucus of Crete	12 grm.

Grind the seeds; macerate for two days in 4 l. of alcohol (85°). Add 2 l. of water, and distill to obtain 3 l. 800 c. c. Bring the volume up to 10 l. and filter.

Chartreuse, Benedictine and Trappestine.

The formulas of the three varieties of chartreuse are kept absolutely secret by the monks, but the following are imitations which approach it. Owing to the number of ingredients, only an expert liquor manufacturer can produce even a passable article, and the beginner's attempts will probably end in failure.

1. Green Chartreuse.
Chartreuse verte.

Chinese cinnamon	1·5 grm.
Mace	1·5 grm.
Lemon balm, dried	50 grm.
Hyssop in flower tops	25 grm.
Peppermint	25 grm.
Thyme	3 grm.
Costmory	12·5 grm.
Genepi	25 grm.
Arnica flowers	1 grm.
Popular balsam buds	1·5 grm.
Angelica seeds	12·5 grm.
Angelica roots	6·5 grm.
Alcohol (85°)	6 l. 250 c. c.
White sugar	2 k. 500 grm.

2. Yellow Chartreuse.
Chartreuse jaune.

Cinnamon	1·5 grm.
Mace	1·5 grm.
Coriander	150 grm.
Cloves	1·5 grm.
Socotrine aloes	3 grm.
Lemon balm	25 grm.
Hyssop in flower	12·5 grm.
Genepi	12·5 grm.
Arnica flowers	1·5 grm.
Angelica seeds	12·5 grm.
Angelica root	3 grm.
Cardamom, small	5 grm.
Alcohol (85°)	4 l. 250 c. c.
White sugar	2 k. 500 grm.

3. White Chartreuse.
Chartreuse blanche.

Chinese cinnamon	12·5 grm.
Mace	3 grm.
Cloves	3 grm.
Nutmeg	1·5 grm.
Tonka bean	1·5 grm.
Lemon balm	25 grm.
Hyssop flowering tops	13·5 grm.
Genepi	12·5 grm.
Angelica seeds	12·5 grm.
Angelica roots	3 grm.
Cardamom, small	3 grm.
Sweet flag	3 grm.
Alcohol	5 l. 25 c. c.
White sugar	3 k. 750 grm.

The aromatic materials are cut or crushed. Macerate all for 24 hours in alcohol. Add water from one-half to two-thirds of the latter. Distill so as to obtain nearly all the alcohol. Add the same quantity of water as the first time. Rectify to obtain the largest quantity of liquor of the best quality. To this is mixed when cold a sirup made by the aid of heat, of sugar and two-thirds its weight of water. Raise the volume to 10 l. Color if necessary, using saffron for the yellow, or Persian berries, with chlorophyl for the green. Allow the liquor to repose, and filter.

Benedictine.
Benedictine.

Imitation of the liquor of the monks of Técamp.

Cloves	2 grm.
Nutmegs	2 grm.
Cinnamon	3 grm.
Lemon balm	6 grm.
Peppermint	6 grm.
Fresh angelica roots	6 grm.
Genepi (Swiss)	6 grm.
Sweet flag	15 grm.
Cardamom, small	50 grm.
Arnica flowers	8 grm.

Cut and bruise the materials, and macerate for two days in 4 l. of alcohol (85°). Distill after having added 3 l. of water, so as to draw off 4 l., to which is added a cold sirup made with 4 k. of sugar and 2 l. of water. Bring up the volume to 10, color yellow, and filter.

Trappistine.

Large absinthe	40 grm.
Angelica	40 grm.
Mint	80 grm.
Cardamom	40 grm.
Lemon balm	30 grm.
Myrrh	20 grm.
Sweet flag	20 grm.
Cinnamon	4 grm.
Cloves	4 grm.
Mace	2 grm.
Alcohol (85°)	4 l. 500 c. c.
White sugar	3 k. 750 c. c.

Proceed the same as for chartreuse. After two days of maceration, distill and rectify, and color green or yellow.

(*To be continued.*)

SKATING RINK WITH ARTIFICIAL ICE.

It will soon be three years since, under the name of the "Ice Palace," we described an installation designed to permit of skating upon genuine ice in all seasons. The company that undertook to carry out this idea rented the spacious hall of the Plaza de Toros, on Pergolese Street, and we had an opportunity of seeing there, for an instant, the immense arena of 2,000 meters transformed into a sheet of water. But when it was necessary to freeze the latter, and the machines began to work, it was found somewhat later that there were many defects in the installation, and that it was possible to make ice only upon the edges, and even then not in a continuous manner. The directors then, taking a firm resolution, had cartloads of cracked ice brought and packed it in the arena. A few skaters had an opportunity of trying their skill upon it, but in the space of one night all was melted and the enterprise, so to speak, fell into the water. It was a folly, too, to wish to do in a few weeks what required several months of study and labor. But the idea was a good one, and was again taken up. Now skating is (and has been since the first of October) going on day and night at the "North Pole," on Clichy Street. This time the installation has been well conducted. Time has been taken, and everything has been studied and put in place with care. The principle is the same as that employed previously, and our first engraving (Fig. 1) represents the machinery room, very well arranged by Engineer Stoppani. It comprises, to the left, two steam engines of 50 horse power each, of the Corliss type, with Stoppani distributer, which run two double-acting Fixary ice machines. These machines are pumps designed to convert ammoniacal gas into liquid ammonia. To this effect, they in the first place force the gas into the large condensers represented to the right. Here it is cooled by a circulation of water derived from the city mains, and becomes liquefied in the small cylinders seen in the foreground. Thence the ammonia is led into the large reservoirs or refrigeratories that are observed upon a platform in the rear, and expands therein with the production of cold. Having returned to the gaseous state, it is taken up again by the machines, which force it anew into the condensers, and so on indefinitely. It is always the same supply of ammonia that is used. The lowering of the temperature produced by the expansion is utilized for cooling an uncongealable liquid (solution of calcium chloride) which circulates in spirals in the center of the refrigeratories. This liquid, by means of a pump, is forced into the pipes placed upon the floor of the rink.

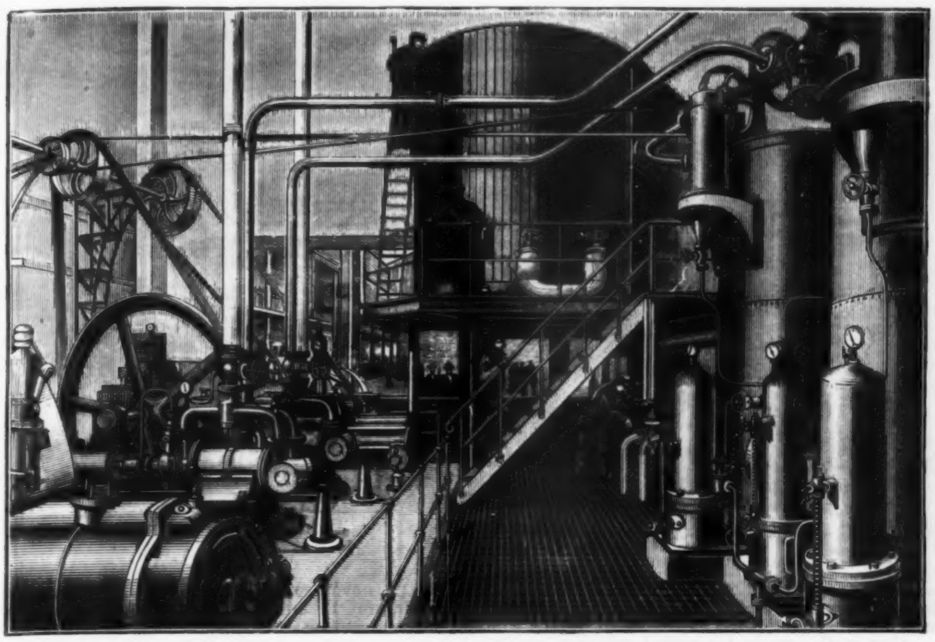


FIG. 1.—MACHINERY HALL OF THE SKATING RINK WITH ARTIFICIAL ICE AT PARIS.

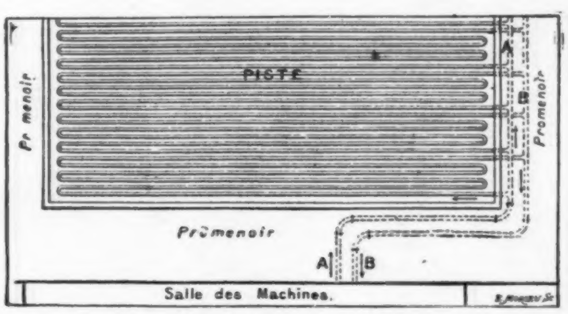


FIG. 3.—PLAN OF CONGELATION PIPING.

A, pipe through which the freezing liquid enters; B, pipe through which it makes its exit.

FIG. 2.—SKATING RINK WITH ARTIFICIAL ICE AT PARIS.

There is here a notable difference as compared with the installation previously tried, wherein the ammonia was expanded directly in the pipe, of the rink—an arrangement evidently defective, because of the leakages inevitable in a system of piping several kilometers in length.

The rink (Fig. 2) is 40 meters in length by 18 in width. It consists of a cement and cork floor resting upon a perfectly tight metallic foundation, and upon which is arranged a series of connected iron pipes having a total length of 5,000 meters. Each section derives its supply from two principal conduits, A and B (Fig. 3), into which constantly flows the solution of chloride of calcium cooled to a temperature that varies according to the velocity of the circulation, which can be regulated at will. When the external temperature is not very high and it is merely a question of keeping the ice in condition, a few degrees below zero will suffice, while, on the contrary, when the upper stratum, or even the entire rink, is renewed, it is necessary to descend to 15 or 20 degrees. The surface is renewed every night. After the snow produced by the incisions of the skates has been removed, there is spread over the remaining ice by means of a pump a sheet of water that circulates during the entire period of its congelation, in order to give a perfectly even surface. In order to prevent the spirals from producing changes of level through the contractions due to the differences in temperature to which they are submitted, they are composed of pipes that enter each other with friction to a certain length. They thus form slides that allow of a certain play. Moreover, in order that their temperature shall be as uniform as possible, care is taken to frequently change the direction of the current. In this way there is secured a uniform mean temperature in the entire circulation.

It will be seen that in this installation everything has been studied out and provided for to the least details. So, during the month or more that it has been in operation, nothing wrong has occurred, and the numerous lovers of skating have always been able to pursue their favorite exercise as well as if they were on the lakes of the Bois de Boulogne in midwinter.

A portion of the power of the motors is employed for lighting the hall, which is decorated with winter scenery. But no attempt has been made to push realism farther, and a heating apparatus keeps up a temperature of from 15 to 18 degrees.—*La Nature.*

A SIMPLE CONTINUOUS POLARISCOPE TUBE.

In casting about for some time and labor saving device in the laboratory of the Utah Sugar Co., the writer tried the experiment of transforming a common 200 mm. (Schmidt & Haensch) polariscope tube into a continuous tube. For this purpose one of the common bayonet clutch brass tubes was taken to the machine shop and a +6 mm. hole drilled in each shoulder, care being taken not to break through into the tube; then a second hole of smaller size was driven from the angle of the end face and interior walls to the bottom of the 6 mm. hole. A 50 mm. length of 6 mm. (external diameter) brass tube was then soldered into each shoulder to act as supply and drain pipes respectively. The accompanying sketch will show the simple construction clearly:

Two ordinary caps were next made to fit the tube by sawing a notch in each for the accommodation of the upright tubes. Two round holes were made in the cover of the polariscope, so that when the tube was placed in position and the instrument closed the two brass pipes projected through the cover. To one of these a 1½ in. glass funnel was attached by a rubber hose an inch in length, and to the other a glass elbow which led to a small drain pipe emptying into a waste pail underneath the working table.

Upon putting the tube in use it was found to work perfectly, even with the varying solutions occurring in control work of a factory.

Several minor precautions are necessary, however; the ends bearing the glass disks must be lightly smeared with some stiff paste (vaseline) to avoid leakage, but care must be exercised, of course, to avoid clouding the glasses thereby. Again, before beginning to polarize, the tube should be filled with water from a convenient siphon to expel the air and thus prevent the formation of bubbles. Thus arranged an assistant can rapidly pour in the various solutions, proceeding from one to another as polarization is effected, or the polarizer himself can pour. The solutions displace one another perfectly and the readings are as close as successive readings of an ordinary tube; it is exact.

The quantity necessary for displacement varies with the nature and density of the two solutions. In general 40c. c m. will be enough, though as low as 20 c. cm. is frequently sufficient. The writer has subjected it to the hardest tests with entire success—fullmasse polarizing 85 has been followed by pulp of only 0·2 of 1 per cent., and the displacement was complete, as proved by polarizing a portion of the same solution in an ordinary tube.—*Hubert Dyer, in the La. Planter.*

The German post office officials have been experimenting with the North Sea cable, seventy-five kilometers long, between Heligoland and Cuxhaven, to test the possibility of using submarine cables of considerable length for telephonic purposes. The results have been very favorable, distinct communication having been obtained at both ends.

THE CONTINUOUS USE OF CONDENSING WATER.

Attention has been called several times in these columns to the introduction and growing use of systems for the recooling and continuous use of condensing water. This system finds its application in situations where the high price of fuel renders the superior efficiency of the condensing engine particularly desirable, while water for condensing purposes is expensive or difficult to obtain.

In San Francisco there has been developed a system, principally through the efforts of Mr. J. C. H. Stut, of cooling the water after it has left the hot well, by means of a system of pans upon the roof. These pans are shallow troughs of galvanized iron arranged in tiers, on a slight incline, so that the water flows back and forth for 1,500 or 2,000 feet, cooling by evaporation and radiation as it flows. The pans are about five feet in width, and the water as it flows has a depth of about half an inch, the temperature being reduced from about 140° to 90°. This system is in use in a number of plants in California, and in all cases a material saving over running non-condensing or supplying the condenser directly from the city mains has been demonstrated. Fig. 1 shows this system in use upon the roof of the California Street Railway Company's power house in San Francisco. The water from the hot well is pumped up to the highest point of the cooling system, and allowed to flow as above described, discharging finally into the main tank or reservoir shown in the middle foreground, whence it again flows to the condenser as required. The wheel upon the post at the left forms a guide for a cord one end of which is attached to a float in the last pan or main reservoir.

The cord leads to an indicator in the engine room below, which shows the height of water above the strainer at the outlet to the condenser. As the water in the reservoir lowers from evaporation, an auxiliary feed from the city mains to the condenser is operated, thereby keeping the amount of water in circulation practically constant. The round wooden tank in front of the chimney is used to charge the pans and to furnish water to the condenser while the pans are undergoing a cleaning and scouring. An accumulation of oil from the engines, with dust from the surrounding streets, makes such a cleaning necessary about once in six weeks or two months. In the last tank a series of vertical partitions are set in such a manner as to cause the water to flow back and forth as well as onward. This feature is found to be of little or no value. A number of devices have been tried for catching the oil, with not very satisfactory results. Several screens of plain wire mesh placed in the last pan in such a manner that they may be easily removed and cleaned every few days is found to give better satisfaction than more elaborate arrangements. There are at this station a set of three engines, worked triple expansion. The cylinders are 14, 20, and 30 inches in diameter, with a stroke of 52 inches, cranks set at angles of 120°. The valve motion is of the O'Neil cut-off type, fitted with the Stut compensating valve gear, by means of which the cut-offs in the several cylinders are varied in accordance with changes of load or pressure. Notwithstanding the enormous variations of power, in some cases the load changing from 20 to 500 horse power in less than three minutes, the engines are worked with very satisfactory results, both as to efficiency and regulation. Though run normally triple, the engines may upon occasion be worked compound or single, and non-condensing, in either case, should anything occur to the condensing machinery. It is found by comparative trials running condensing and non-condensing, that about 50 per cent. less water is taken from the city mains when the whole apparatus is in use than when the engine is run non-condensing. Twenty-two to twenty-three inches of vacuum are continuously maintained, and it is noticed that a better vacuum is obtained on a warm day with a brisk breeze blowing than on a cold day with but a slight movement of the air.

Fig. 2 shows the plan adopted by the San Francisco and San Mateo electric road. The water from the hot well is here sprayed from a number of fountains, and also from a pipe extending around its border, into a large pond, the exposure cooling it sufficiently for the obtaining of a good vacuum by its continuous use. Here also triple expansion engines are used, with satisfactory results, in connection with the condensing and cooling apparatus.

Somewhat upon the same principle is the system shown in Fig. 3, recently patented by the Messrs. See, of Lille, France. The water is discharged from the pipe shown through a series of special nozzles, by which it is projected into a fine spray. On coming into contact with the air in this state of extreme division the water is cooled 40 to 50 degrees, with a loss by evaporation of only one-tenth of its mass, and produces an excellent vacuum. A three thousand horse power cooler upon this system has been erected at Lannoy, one of 2,500 horse power at Madrid, and one of 1,200 horse power at Liege, as well as others at Roubaix and Tourcoing. The system could be used upon a roof if ground space were limited.

Fig. 4 shows an arrangement adopted by the Worthington steam pump people for supplying water to their condensers attached to vacuum pans in some instances in the South, but equally applicable to engine practice. The independent condenser is placed in the lower story, controlled by handles extending downward from the floor where the pan is located. The injection water is taken from the tank, as shown, and after having passed through the condenser is discharged in a heated condition to the top of the cooling tower, where it is scattered by means of distributing pipes. The water falling from top to bottom of the tower is lowered in temperature by the cooling effect of the atmosphere, and the absorption of heat caused by a portion of the water being vaporized, and is led to the tank to be again started upon its circuits.

An apparatus for the purpose in hand was described by R. O. Heinrich, M.E., in our August issue, and in order that the *résumé* may be reasonably complete, is introduced here in Fig. 5. In this apparatus, patented in Germany by a Mr. Klein, the hot water coming from the condenser enters at the top of a wooden structure about twenty feet in height at the bottom of narrow metal tanks. The water overflowing from these tanks is spread as a thin film over a series of wooden partitions suspended vertically about 3½ inches apart within the tower. The upper set of partitions, corresponding to the number of metal tanks, reaches half way down the tower. From there down to the well is suspended a second set of partitions placed at right angles to the first set. This has the double advantage of impeding the rapidity of the downflow of the water and also of thoroughly mixing the water, and thus affording a better cooling. By means of these partitions a spraying of the water is avoided, which is somewhat essential, since it prevents the water from absorbing air, an important fact if the water is used in a rotation process in the air pump of the condenser. A fan blower at the base of the tower drives a strong current of air with a velocity of about twenty feet per second against the thin film of water running down over the partitions.

As to the capacity of the blower, it is estimated that for an effectual cooling two thousand times more air than water must be forced through the apparatus. With such a velocity the air absorbs about two per cent. of aqueous vapor. The action of the strong air current is twofold—first, it absorbs heat from the hot water by being itself warmed by radiation; and secondly, it increases the evaporation, which process, as is well known, absorbs a great amount of heat. These two cooling effects are different during the different seasons of the year. During the winter months the direct cooling effect of the cold air is greater, while during summer heat absorption by evaporation is the more important factor. Taking all the year round, the effect remains very much the same. The evaporation is never so great that the deficiency of water would not be supplied by the additional amount of water resulting from the condensed steam, while in very cold winter months it may be necessary to occasionally rid the cistern of surplus water. The cooled water collects in a cistern at the bottom of the tower, where all oily matter comes to the surface and is removed at intervals. Although air is circulating freely over the water, the reabsorption of air is only very trifling, which may be ascribed to the circumstance that the condensing water remains in contact with the air for only a very short time (about one second in a twenty-foot tower), and that all splashing and spraying of the water during its descent is avoided by means of the partition over which it runs in the shape of a thin film.

For one horse power, 3·6 square yards of cooling surface is necessary. The vertical suspension of the partitions is very essential. In trial it was found that a horizontal arrangement showed only half the efficiency

Fig. 1.

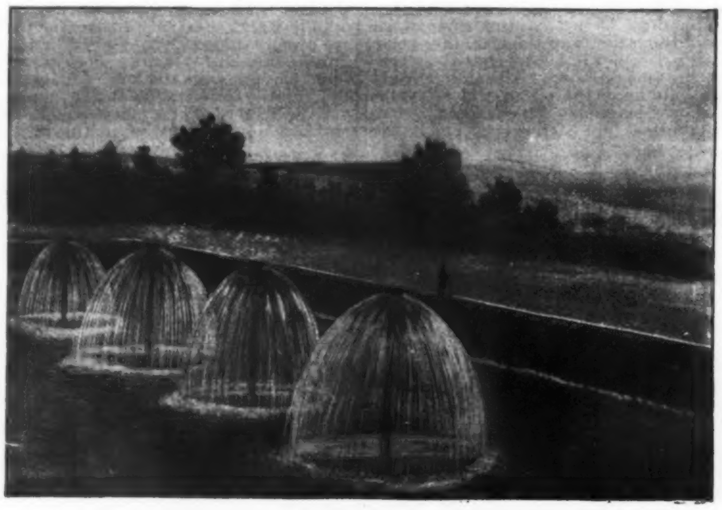


Fig. 2.

Fig. 3.

of cooling, partly because the air current was greatly impeded and partly because the horizontal layers of air were rapidly saturated with aqueous vapor, thus preventing an effectual cooling by evaporation. If it is desirable to employ simply air cooling without the help of a fan blower, the cooling areas must be increased about five times. The following results of tests speak well for the efficiency of the apparatus.

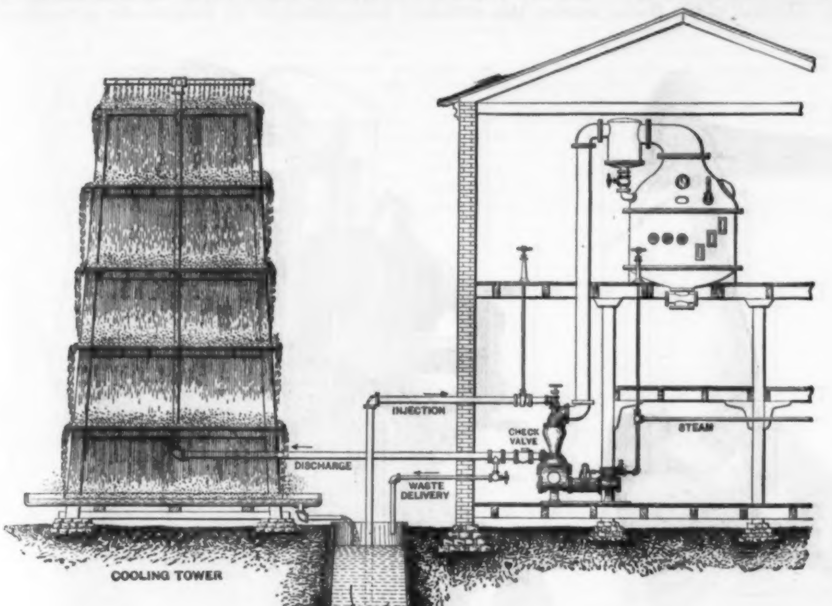


FIG. 4.

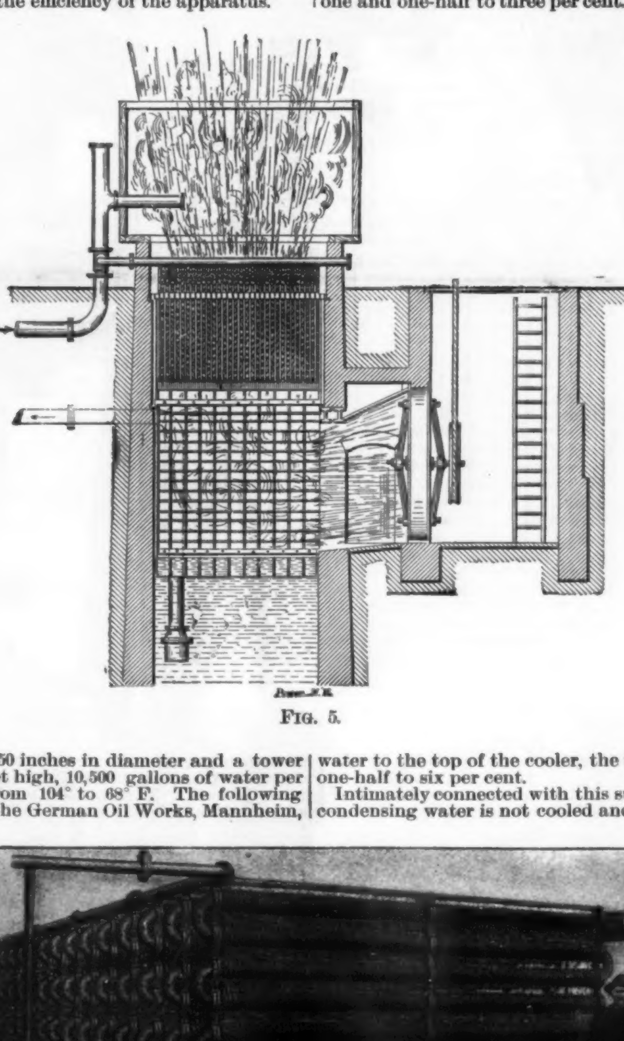


FIG. 5.

With a ventilator 50 inches in diameter and a tower 6 by 7 feet and 20 feet high, 10,500 gallons of water per hour were cooled from 104° to 68° F. The following record was made at the German Oil Works, Mannheim, Germany. Vacuum in condenser, 28·1 inches; temperature of condensing water entering at top of tower, 104° to 108° F.; temperature of water leaving the cooler, 66·2° to 71·6° F. The engine was of the Sulzer compound type, of 120 horse power. The average pressure of the exhaust of the low pressure cylinder was, without condensation, 1·5 to 2·3 atmospheres. With the use of an injection condenser and Klein's condensing water cooler the exhaust pressure was reduced to 0·5 of an atmosphere, the saving in fuel amounting to $25 per day. The amount of power necessary for the arrangement amounts, for the ventilator, to about three per cent. of the total horse power of the engine, and from one and one-half to three per cent. for the lifting of the water to the top of the cooler, the total being four and one-half to six per cent.

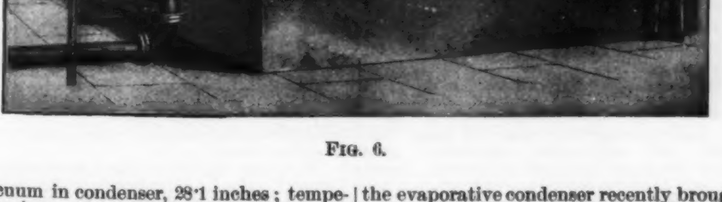


FIG. 6.

Intimately connected with this subject, although the condensing water is not cooled and used over again, is the evaporative condenser recently brought out by the engineering firm of T. Ledward & Co., of Brockley, London, and described in a recent issue of the *Practical Engineer*. Obviously if a pound of steam of atmospheric pressure or less can be made to give up enough heat to evaporate a pound of water in the atmosphere, it will itself be condensed. The idea of this condenser is to allow water to trickle over the pipes of the large condenser or radiator shown in Fig. 6, and by evaporation to carry away the heat necessary to be abstracted to condense the steam inside. It will be seen that the condensing pipes are of a special kind, being fitted with corrugations mounted with circular ribs, whereby the radiating or cooling surface is very largely increased. The pipes, which are cast in sections about 76 inches long by 3½ inches bore, have a cooling surface of 26 square feet, which is found sufficient under favorable conditions to permit of the condensation of 20 to 30 pounds of steam per hour when producing a vacuum of 13 pounds per square inch. In the condenser shown in the illustration, and which has now been at work for some time, with the most satisfactory results, at the works of the Deutsche Linoleum Co., at Rixdorf, near Berlin, a vacuum ranging from 24 to 26 inches of mercury was constantly maintained during the hottest weather of August. The initial temperature of the cooling water used in the apparatus under notice ranged from 80° to 85° F., and the temperature in the sun, to which the condenser was exposed, varied each day from 100° to 115° F., so that it will be seen the conditions were not at all favorable, and with cold weather there is no doubt a better vacuum than that recorded will be obtained.

During the experimental trials several points were brought out which are worthy of record. It was found, for instance, that it was possible to run one engine under a load of 100 horse power, and maintain the full vacuum, without the use of any cooling water at all on the pipes, radiation afforded by the pipes alone sufficing to condense the steam for the power mentioned. Further, it was found that the air pump could be stopped and the engines run under full load for nearly half an hour before the vacuum was entirely obliterated—a point which it will be seen may, under certain circumstances, prove useful, since it will admit of the air pump valves being examined without stopping the engines.

It may be explained, as fears had been expressed by some that in connection with this installation trouble might be experienced with the pipe joints, that, although there are four hundred in the condenser itself, not the slightest hitch or difficulty was experienced during the course of the trials, although the apparatus was subjected to much greater strains than are likely to occur during ordinary work. Thus, on several occasions the pipes were made hot by passing the exhaust steam through them, and then suddenly cooled by turning the condensing water upon them from the distributing mains. None of the joints, however, suffered from this rather trying treatment—a fact which fully lays the fears in question at rest, and affords gratifying testimony to the designers with regard to the efficiency with which provision was made for expansion in every direction.—*Power.*

HIGH RAILWAY SPEEDS IN FRANCE.

THE regulations of the Northern Railway fix the extreme limit at 75 miles an hour, but at the same time the drivers are advised not to exceed 70 or 72. The train referred to left Amiens at 4:4 P. M., October 29—21 minutes late—with a train of nine coaches weighing 100 tons, and covered the distance to the Paris terminus—81½ miles—in 1 hour 27½ minutes; the arrival being at 5:31½ P. M., or five minutes behind the table time. This gives, therefore, an average speed of 55·6 miles per hour for the whole distance, or allowing a half-minute for the slowing up, in round figures 56 miles per hour.

The engine, No. 2,122, was coupled on at Amiens, and the boiler pressure of 170 lb. was maintained by frequent and light firing from commencement to finish, with very little variation above or below. The normal water level was also regularly kept up. Getting away quickly without any slip, the first five miles up gradient were covered at 38 miles per hour; the 17 miles succeeding—to Breteuil—were mounted at an average of 55½ miles per hour; and the remaining five miles, up an incline of 1 in 250 to the Gannes summit, were completed at 49½ miles per hour. The first falling gradient then succeeds, and is continuous to Creil, a distance of 23 miles—covered easily at 60 miles per hour; after which follow a series of gradients rising 1 in 200 as far as Survilliers—13 miles—and which were mounted at the speed of 54 miles per hour. From this point the road falls all the way to St. Denis, in the neighborhood of Paris—16 miles, cleared at the average of 68½ miles per hour—and the 2½ miles intervening before the Paris terminus is reached were run over with closed regulator at a stopping speed of 28½ miles per hour average.

On the last descent the highest speeds of any portion of the route were attained. Between the eighth and seventh miles 75 and 74 miles per hour were made, with the regulator slightly closed and the admission to the high pressure cylinders 40 per cent. and to the low-pressure 70 per cent. of their openings, pressure in the receiver being 16 lb. At no portion of the route was steam admitted direct to the receiver. The movement of the engine at all speeds was very steady, due to the bogie and to the equalized distribution of the work of the cylinders and also of the weights of reciprocating parts. Over a dozen locomotives of the same type are now in course of construction.

	Times. h. m.	Distances run. Miles.
Amiens	4 4	...
	4 12	5·3
	4 30½	17
Gannes	4 35½	4·7
Creil	4 58½	23
Survilliers	5 13	13
St. Denis	5 27	16
Paris terminus	5 31½	2·5
		81·5

In special experimental trains not conveying passengers the same engines have run at 81 miles per hour on the falling gradients.—*The Engineer.*

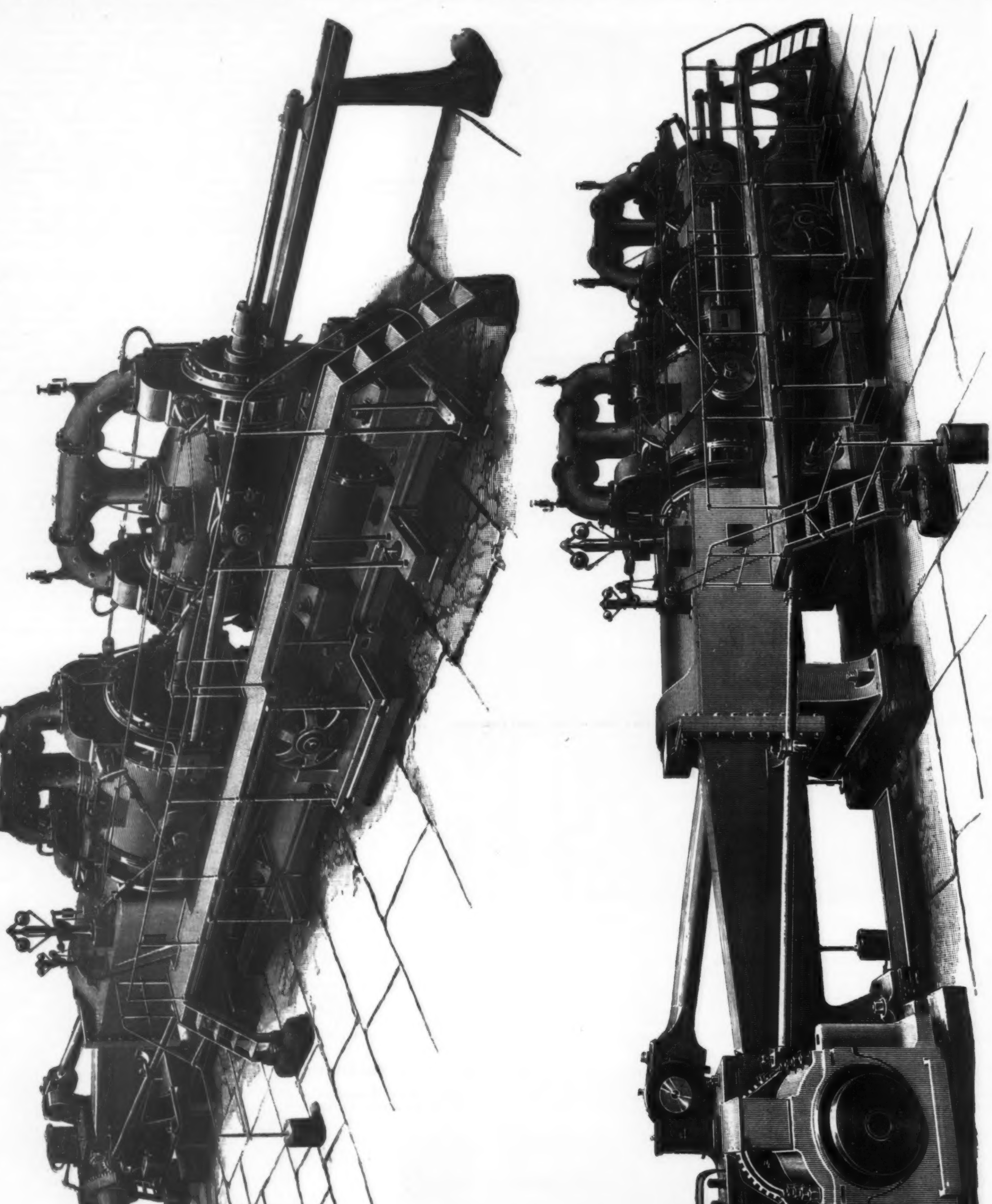
A NEW material, called rubber velvet, is made by sprinkling powdered felt of any color over rubber cloth while the latter is hot and soft; the result looks like felt cloth, but is elastic, waterproof and exceedingly light.

1,600 INDICATED HORSE POWER TANDEM MILL ENGINE.

WE illustrate an engine recently constructed by Messrs. Hick, Hargreaves & Co., Limited, Bolton, for the Nevsky Mill, of the Nevsky Thread Manufacturing Company, St. Petersburg. This engine, now being erected in Russia, is intended to drive an extension of one of the company's mills, and its type was largely determined by the necessity that it should occupy an existing foundation, originally put down with the intention to provide for the future duplication of the 1,100 indicated horse power tandem engine already working in the same engine house. As regards the form of frame and class of valve gear, the new engine is of the makers' well-known Corliss type, the main frame being in two pieces, with a bolted joint at the center of its length, at which point it has a foot supporting it from the foundation, embodied with a stay bracket connecting the upper and lower crosshead guides. The half of the frame nearest the cylinders is a massive casting weighing some 15 tons, fitted with separate and adjustable crosshead guide bars. The low pressure cylinder is bolted directly to this frame, and both cylinders are carried on a deep girder bedplate, arranged to maintain them in line vertically and laterally, but to leave them free to slide longitudinally, the strains in this last direction being entirely borne by two turned wrought iron stays having T ends bolted to the cylinders.

In accordance with the builders' practice, each cylinder is built up of a working barrel, a jacket, and two end pieces containing the valve chambers, a method of construction which substitutes four comparatively simple castings, each of which can be cast of the metal most suited to its purpose, for a single casting of a complicated character, which would have to be cast of a soft mixture.

This plan has the further advantage of simplifying repairs. Each cylinder has its barrel and covers jacketed, and takes its steam supply through its own jacket; special arrangements being made for draining the jackets into large receivers fitted with gauge glasses, traps and blows through valves. Apart from this the considerable economy claimed to result from this



IMPROVED 1,600 INDICATED HORSE POWER TANDEM MILL ENGINE.

IMPROVED 1,600 INDICATED HORSE POWER TANDEM MILL ENGINE.

method of jacketing, due to the perfect circulation obtained, it has important practical advantages. No unsightly pipes are required above the floor level, and the barrel and jacket are maintained at one uniform temperature, avoiding the unequal expansion which is found to be a frequent source of trouble with long-stroke jacketed cylinders. Both cylinders are fitted with the "Inglis & Spencer" Corliss valves and gear, driven through bevel gearing from the crankshaft by an inclined shaft, and a cross shaft between the cylinders. The steam valves are worked on one side of the engine, and the exhaust on the other, the resulting separation of the eccentrics, of which there are two for steam and two for exhaust, rendering them easily accessible for adjustment. The piston rod is supported between the cylinders by an adjustable brass block, and both it and the valve spindles have Crookshank's metallic packings throughout. The crankshaft is of Siemens-Martin steel made by the Bolton Iron and Steel Company, bored throughout its length to ascertain its internal soundness, and the journals are each provided with a pump to return the oil from a lower receiving cistern fitted with strainers, to an upper supply box with glass sides. The flywheel is grooved for rope driving and built up of two bosses, with two sets of arms socketed into the bosses and bolted to the rim segments, the joints throughout being accurately machined. The wheel is cased with wood and has a barring rack cast on the inside of the rim; a barring engine of the makers' usual pattern being provided for moving or starting the engine.

In cotton spinning, uniformity of speed is of great importance, and the heavy flywheel running at a high peripheral velocity is sufficient to prevent any perceptible variation in any one revolution. To maintain the number of revolutions per minute also constant, in spite of changes of load and steam pressure, the engine is fitted with a Knowles' supplementary governor, in addition to the powerful high speed main governor, both being driven off the inclined shaft. A safety trip gear is fitted to release the high pressure trip rods, and so cut off the steam supply in case of the failure of the gearing driving the main governor; and, as a further precaution, the main steam valve is fitted with Tate's electrical stop motion, arranged to act at overspeed, and to be worked by pushes from various parts of the mill. The air pump is vertical, driven by links and plate levers off the crosshead gudgeons, the cover being fitted with hinged relief valves, and the condenser is provided with a high level supplementary injection for use at starting.

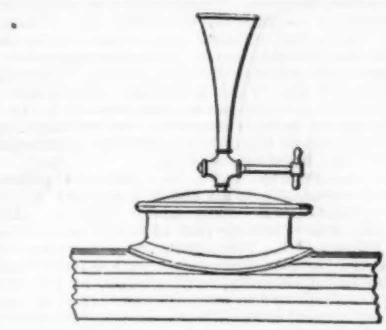
In addition to the special features referred to, the engine has a full complement of the fittings usual to large mill engines, such as planished steel cylinder lagging, indicator cocks and gear, complete lubricators, brass oil catchers and screen, a steam separator, handrails round the engine, flooring over the air pump pit, a Moscrop recorder, etc. The following are the leading dimensions and particulars:

Boiler pressure	90 lb.
Cylinders, diameters	38 in. and 64 in.
" stroke	6 ft.
Air pump	38 in. diameter by 30 in. stroke.
Revolutions per minute	50
Piston rod diameters	5½ in., 7½ in. and 9 in.
Connecting rod, length, centers	17 ft. 6 in.
Crank pin	12 in. diameter by 14 in. long.
Crank neck journal	20 in. diameter by 31½ in. long.
Out end journal	20 in. diameter by 36 in. long.
Flywheel, diameter	32 ft.
" number of ropes	30
" weight	84 tons.
Total length of engine	69 ft. 4½ in.
" weight "	213 tons.

In addition to the above tandem engine Messrs. Hick, Hargreaves & Co., Limited, have, under the same contract, recently supplied for the Nevsky mill of the company a side-by-side compound receiver engine also of 1,600 indicated horse power, having cylinders 36 in. and 62 in. in diameter by 6 ft. stroke, for 50 revolutions and 100 lb. steam pressure. Apart from the difference in type to suit the location, the engine is of the same general character as the tandem. For the above particulars and for our illustrations we are indebted to *Engineering*.

THE FIRST LOCOMOTIVE WHISTLE.

WRITING of early railway appliances, Mr. Clement E. Stretton, C.E., in the *English Mechanic*, says: "The invention of the first steam trumpet or whistle for locomotive engines has lately received much attention. The following facts and illustration may therefore prove of interest to your readers: During the first few weeks of the year 1833 the Leicester & Swannington Railroad Company's engine, the Samson, ran into a horse and cart crossing the line at the 'Stag and Castle,' Thornton, the cart being loaded with butter and eggs for the Leicester market. The engine driver had only the usual horn, and could not attract attention. Mr. Ashlen Bagster, the manager of the railway, went the same Saturday afternoon to Alton Grange, Snibstone, to report the circumstance to Mr. George Stephenson, who

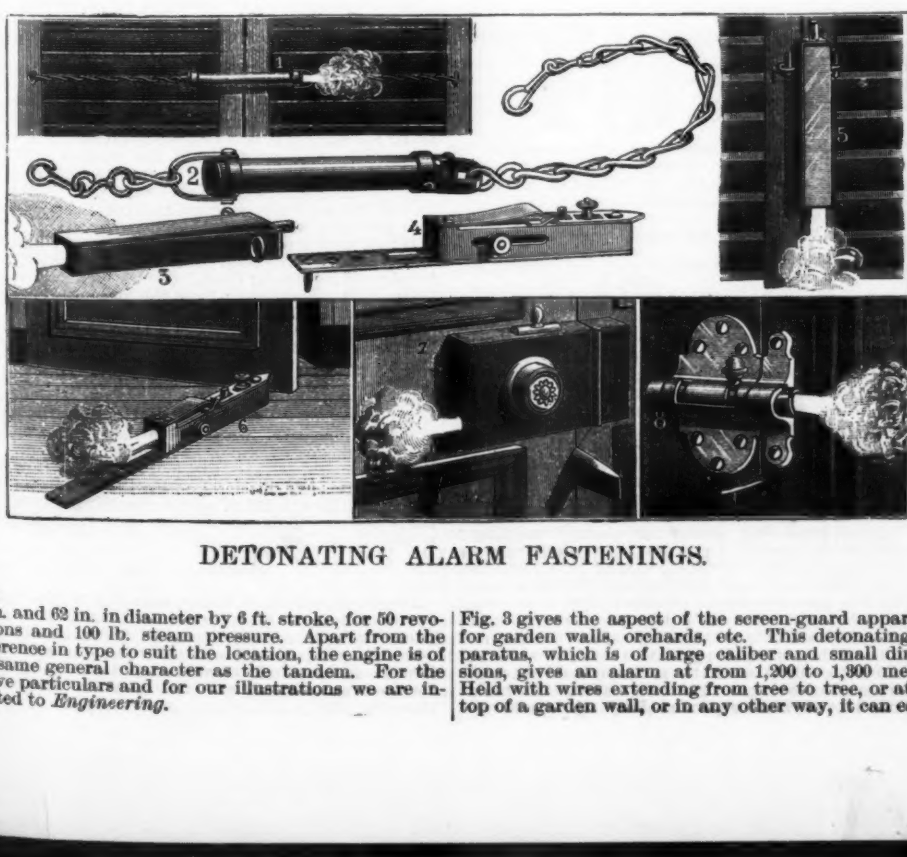


was one of the directors and the largest shareholder. After various ideas had been considered, Mr. Bagster remarked, 'Is it not possible to have a whistle fitted on the engine which steam can blow?' George Stephenson replied: 'A very good thought; go and have one made.' And such an appliance was at once constructed by a local musical instrument maker. It was put on in ten days and tried in the presence of the board of directors, who congratulated both Bagster and Stephenson, and ordered more trumpets to be made for the other engines which the company possessed. The company had to pay for the horse and cart, 50 pounds of butter, and 1,000 eggs; after which strict instructions were issued that 'under no circumstances should any of the company's locomotive engines run unless fitted with the steam trumpet.' The annexed diagram is taken from the official drawing signed by Mr. H. Cabry, the company's engine superintendent, May, 1833."

ALARM FASTENINGS.

THE newspapers have recently contained numerous accounts of robberies committed by burglars in various quarters of Paris. The moment appears to us opportune to make known the new system of alarm fastenings due to Mr. Paul Blanchet. With the apparatus that we are about to describe, as soon as an attempt is made to pick a lock, introduce a skeleton key, use a "jimmy" or other lever to pry off a bolt or the hinges of a door, or to saw the panels, a loud detonation occurs, while, at the same time, an electric bell continues to make itself heard. The detonation is produced by the explosion of a harmless cartridge, and the ringing of the bell by an electric circuit that is closed by the effect of the burglar's tentatives.

Our engraving represents the principal apparatus of Mr. Blanchet. Fig. 1 is the detonating safety chain for windows, verandas and shutters. This chain constitutes a kind of supplementary fastening that is perfect by its force of resistance. Moreover, at the least tentative of burglars, it gives an alarm throughout the entire house and to all the neighbors. When an endeavor is made to open the shutters from the outside, the chains represented in the figure are drawn and act upon a spring located in the central cylinder to which they are attached, and, through a gearing, cause the explosion of a cartridge. Fig. 2 shows a chain for apartment doors, which operates in the same manner.



DETONATING ALARM FASTENINGS.

Fig. 3 gives the aspect of the screen-guard apparatus for garden walls, orchards, etc. This detonating apparatus, which is of large caliber and small dimensions, gives an alarm at from 1,200 to 1,300 meters. Held with wires extending from tree to tree, or at the top of a garden wall, or in any other way, it can easily be concealed. It can also be left exposed indefinitely to moisture without the cartridge that it contains undergoing any alteration. Figs. 4 and 6 represent a small movable detonating apparatus to be placed upon the floor behind a door. A point placed at one extremity and entering the wood of the floor fixes it in such a way that the least impact upon the detent, which is at the other end, causes the explosion of the powder. Whether one be present or absent, it serves to keep the door closed.

Fig. 5 represents a window guard. An eyebolt fixed on each side of the shutter permits of hooking this little apparatus thereon or of removing it at will.

Figs. 7 and 8 show a detonating lock and bolt, alarm bell and electric light. As a measure of precaution, each lock is provided with two different kinds of keys —a safety key, which opens all the parts of the lock, and a latch key, for outgoings and incomings. This latter is capable of opening only the half turn and gives no idea of the form of the safety key. Finally, in order that nothing may be wanting in this lock, a contact, placed in the interior and set in motion by the double turn, lights, when it is desired, one or more incandescent lamps, which require for their maintenance but a few moments' looking after every two or three months, and the expense of which is insignificant. Such lighting, obtained by opening a lock, may be of very great utility on coming in at night or entering a dark antechamber.

The detonating sliding bolt (Fig. 8) is designed for interior doors and servants' staircases. It gives an alarm without opening as soon as an attempt is made to force the door. It is unnecessary to say that the mechanism is so arranged that a detonation can never occur in ordinary use.—*La Nature.*

DEVELOPMENT OF ELECTRIC METAL WORKING.

By FREDERICK P. ROYCE.

AT the recent meeting of the Carriage Builders' National Association, says *The Hub*, President Hooker introduced Frederick P. Royce, of Boston, who spoke as follows:

The art of working metals by electricity, the invention of Professor Elihu Thomson, embraces the various operations of welding, brazing, shaping, forming, and tempering; but the department of work in which carriage and wagon manufacturers are specially interested is that of electric welding, and while it may not be best at this time to enter into a thorough technical discussion of the subject, still there are a few fundamental principles which may be interesting, and which will now be detailed briefly.

THE ELECTRIC WELDING PROCESS.

To heat a piece of metal by electricity, the method in practical use is to pass an electrical current having an enormous volume through the piece to be heated; similarly, if we desire to weld two pieces of metal by electricity, we force through the pieces a current having a volume so great that the metal, on account of its resistance, cannot carry it without rapidly inducing heat.

In case the current is forced through the continuous piece of metal, the heat produced is equal throughout; but if we pass the same current through the two pieces of metal touching each other, the resistance is greatest at the point where the two pieces touch, and the heat is necessarily produced there first.

Two pieces of metal cannot be brought so closely together that the resistance at the point of contact will be as low as in the solid metal; consequently, the heat is necessarily first produced at this point, and after it is once generated the resistance at this heated point increases, for the reason that hot metal is always a poorer conductor of electricity than cold metal.

It is consequently a building process. The ratio of increase of resistance and the increase of heat at the desired point become practically constant. When the metal reaches the desired welding temperature the pieces are forced together by end pressure, and a butt weld is made.

This pressure for small sizes of work is supplied by various forms of hand levers, but in larger welding hydraulic pressure is ordinarily used, the hydraulic cylinders for the purpose being a part of and attached to the welding machine.

The result of this end pressure is an enlargement or upset of the metal at the point of contact, the size of the upset depending upon the section of the stock welded. This may be removed in various ways, as will be hereafter described.

There are two distinct types of electric welding apparatus for producing the above results.

The first machines built were planned for what is known as the direct method of welding; those built later and in more general use to-day are of the indirect type, and specially used for larger work.

In the former the dynamo and welding apparatus are combined in one machine, the current passing directly from the collector rings of the generator to the piece to be welded.

In the indirect type the dynamo and welder are separate pieces of apparatus. The dynamo is complete in itself, and can be located near the source of power, connected by wires carrying the current generated to the welder, which can be placed in any convenient location for the work to be done, and at a distance of several hundred feet from the dynamo, if necessary. This makes it possible to place the dynamo or generator in an engine room or near the source of power, and in charge of the engineer, so that it can be cared for at little or no extra expense.

One or more welders can be distributed through the works and in localities where there may be no arrangements for power; but where they can be conveniently operated, several welders can be run from one dynamo; and there are already instances where five, six, or more welders are placed in different buildings and on different floors, running constantly from a common dynamo and fed from a never varying pressure.

The direct apparatus above referred to is found to be advantageous for small work, as the welding of wire, cotton ties, rims for baby carriage wheels, etc., and where cleanliness at the point of welding can be observed. For all larger work, however, the indirect apparatus is far preferable.

The dynamo is of special construction, and varies materially from that used for lighting purposes, and yet can be so built, if desired, as to furnish current for incandescent lamps needed in the works where the welding plant is placed.

The dynamo generates an alternating current of 300 volts, which is less than one-third of that required for the lowest potential primary circuits used for lighting purposes where an alternating current is generated.

The welder itself consists chiefly of a transformer or converter, in which the current of electricity generated in the dynamo is changed from one having a reasonably high electro-motive force and varying volume to one having a very low electro-motive force and an exceedingly large volume. This converted current is carried through an electrical circuit made up preferably of massive copper and the pieces which are to be heated for welding. That is to say, we have a circuit which is made up of several feet of heavy copper and a few inches of iron, steel, or other metal to be welded, in which the voltage is so low that no shock can possibly be given the operator, and no danger whatever can result therefrom.

The power of conducting electricity which the copper possesses is so high that practically no heat is caused in this metal by the electrical current passing through it; but as the current passes through that part of the circuit consisting of the pieces to be welded, the resistance through these pieces is so high that a welding heat at the point of junction is quickly secured. This heat is perfectly and absolutely regulated by reactive coils and other forms of apparatus.

The work is never hidden from the operator, as is necessarily the case in a forge fire; the necessary pressure can be applied at exactly the right moment, and uniformly good results are obtained.

No detrimental foreign matter can be introduced into the weld, as is frequently the case when coal or coke is used; and any impure substance existing in the metal in the immediate vicinity of the weld is ordinarily expelled by this welding process.

To illustrate this, it has been frequently shown that if a piece of iron, after being electrically welded, is ground or planed off and etched with acids, the structure of the metal at or near the weld will be closer and finer than in the original bar, and thorough and exhaustive tests made upon the welds show that an absolutely perfect union has taken place. The metal becomes homogeneous at the point of welding.

METAL WORKING BY THE USE OF THE ARC.

The Thomson electric welding method which has been thus briefly described, sometimes called the incandescent process, is now in quite general use throughout the country. It is totally different from what is known as the arc process, and should always be distinguished from it.

By the arc method, invented by De Meritens, a current of comparatively high voltage is used, one terminal of the generator or other source of current being attached to the metal to be acted upon and a portable carbon pencil forming the other electrode. This pencil is brought in contact with the work at any desired point, establishing the arc, which is maintained until the required heating effect is produced.

The temperature of the electric arc is greater than any other known source of heat, and its application to metal working is destined to play an important part in the manipulation of metal in the near future.

DEVELOPMENT IN ELECTRIC METAL WORKING.

In the year 1888 the electric welding process was first practically applied to commercial work. Machines were rapidly built for various purposes, and welding plants were soon established in various large works throughout the country for a great variety of purposes.

Iron, steel, copper, or brass wires of various sizes are united into long lengths; rods and bars of iron or steel are welded, shaped, and forged by electrical heat; axles, tires, small parts of carriage and wagon work are turned out in large and increasing quantities; tubes of iron or steel are welded together in lengths of several hundred feet, and bent into spirals or oblong coils of sizes and shapes required; parts of bicycles are brazed or welded, as the case may be; iron agricultural wheels are welded spoke to hub, and spoke upset to tire; fine grades of tool steel, as Mushet or Jessop's, are welded to machine steel, forming tool blanks, which may be used with great economy in all machine shops; lead composition plates are electrically connected for storage battery purposes; forgings of ten square inches section are heated by the welding process and united by enormous hydraulic pressure; ship stanchions, rods and shafting are easily welded by powerful machines in our different navy yards, and the field is rapidly broadening for a greater variety of work, and with most satisfactory results.

The newly developed methods of producing aluminum, and the consequent decrease in its cost, promise to open a wide field for this process, as the metal can be welded easily and as quickly as either steel or iron.

Special machines have been necessarily built, adapted to the requirements of these different grades of work. The conditions are constantly changing, and welders varying from 50 lb. weight to that of several tons are built as called for, to meet the demands from various sources.

At the works of the Johnson Company, at Johnstown, Pa., several hundred large welds, in connection with their various forms of road bed construction, are made daily.

There ten square inches of steel or iron are easily welded together, a pressure of 150 tons being supplied by heavy hydraulic appliances to reduce the burr or upset and finish the metal.

Ten complete welders are installed at their works, five of them for rail work alone, and weighing upward of 30 tons each.

The leading carriage and wagon manufacturers were the first in the field, and among those who then became interested in welding by electricity were Studebaker Bros. Manufacturing Co., of South Bend, Ind.; Haydock Bros., of St. Louis, Mo.; the Parry Manufacturing Co., of Indianapolis, Ind.; the Racine Wagon and Carriage Co., of Racine, Wis.; and the Kentucky Wagon Manufacturing Co., of Louisville, Ky.

They investigated the process thoroughly, and electric welding machines are now in active and successful operation in their shops. The Cleveland Axle Manufacturing Co., of Cleveland, O.; the Sheldon Axle Co., of Wilkesbarre, Pa.; and the M. Seward & Son Co., of New Haven, Conn., were also among the first to install apparatus.

COMPARISONS OF COST OF ELECTRIC AND FORGE WELDING.

Inquiries are constantly made as to the cost of electric welding in comparison with that of the older forge methods, and it is to this important matter that it is desirable to give special attention in this paper.

There are two important elements that enter into the cost of welding—the labor required at the welder and the necessary power to drive the dynamo.

Regarding the labor, the engineer always employed in carriage and wagon factories can easily attend to the running of the dynamo. The machine is simple in its construction; it requires but very little care; it must be properly oiled, the brushes and collector rings kept clean, but beyond that needs little or no attention.

One man only is needed to operate the welder where the pieces to be united are of regular shape, and the weight is such that they can be easily handled. In case great rapidity of work is essential, an assistant, generally a boy, will be the only additional helper required to facilitate the handling of stock.

In the case of axle work, two men are generally needed—a blacksmith to do the welding and a helper in reducing the burr or upset under hammer and in setting the axle—turning out easily 150 sets of 1 inch axles or 100 sets of 1¼ inch axles, as the case may be.

In case of light iron buggy tires, one man can easily weld from 700 to 800 daily, with a helper at low wages to bring the stock to the machine and take it away. In the case of steel tires, 400 to 500 can be similarly welded. In heavy wagon tires somewhat more help is needed. At the Studebaker works two heavy tire welders are placed side by side, with a hammer conveniently located, and a force of five men turn out a large product daily.

The smaller parts of carriage and wagon work are easily managed by a single operator. Fifth wheels, step irons, carriage rails, dash irons, and other similar classes of work, are turned out with great rapidity.

The removal of the upset or burr at the point of welding is, of course, an element of cost, and can be removed in a variety of ways. Grinding was at first tried, but this was found to be too slow and expensive in connection with wagon work. Rolling was also attempted, but found to be impracticable commercially. Hammering has been found to be the cheapest and most effective method so far tried.

All welds retain sufficient heat after they are removed from the welding machine to be hammered as much as may be required. Not only does the hammering reduce the burr to the size of the metal, but materially strengthens and improves the weld.

Various hammers have been designed working directly in connection with the welding machine, but with wagon and carriage work the ordinary light power hammer is found to be the most efficient. Either power or hydraulic presses have been found to be efficient in some varieties of work.

When welding apparatus was first introduced into carriage works, the cost of preparation of the parts to be welded was quite an item of expense. It was at that time thought best to remove all forms of oxide which might have accumulated on the steel or iron; but as this required both time and labor, it was speedily abandoned, and it was decided to be more economical to increase somewhat the force of the current used for the welding, even at the expense of additional power required; and no preparation of the metal is now regarded necessary, as far as the ordinary oxide formed by the rolling of metal bars is concerned.

Should there be a heavy red oxide or serious accumulation of foreign matter, it is best to remove this before the weld is made. It is frequently done by pickling, where large quantities of metal are to be cleaned cheaply; but it is only in exceptional cases where this is necessary.

The question of actual horse power required for welding both axles and tires has been carefully considered, and the following figures are based upon actual experience in various works, and from very careful electrical and mechanical tests made by reliable experts:

AXLE WELDING.

1	inch	round	axle	requires	25 H. P.	for	45	seconds.
1	"	square	"	"	30 H. P.	"	48	"
1¼	"	round	"	"	35 H. P.	"	60	"
1¼	"	square	"	"	40 H. P.	"	70	"
2	"	round	"	"	75 H. P.	"	95	"
2	"	square	"	"	90 H. P.	"	100	"

The slightly increased time and power required for welding the square axle is not only due to the extra metal in it, but in part to the care which it is best to use to secure a perfect alignment.

TIRE WELDING.

1	inch	x	¼	inch tire	requires	11 H. P.	for	15	seconds.
1¼	"	x	⅜	"	"	23 H. P.	"	25	"
1½	"	x	⅜	"	"	20 H. P.	"	30	"
1½	"	x	½	"	"	23 H. P.	"	40	"
2	"	x	½	"	"	29 H. P.	"	55	"
2	"	x	¾	"	"	42 H. P.	"	62	"

The time above given for welding is, of course, that required for the actual application of the current only, and does not include that consumed by placing the axles or tires in the machine, the removal of the upset and other finishing processes.

From the data thus submitted the cost of welding can be readily figured for any locality where the price of fuel and cost of labor are known.

In almost all cases the cost of the fuel used under the boilers for producing power for electric welding is practically the same as the cost of fuel used in forges for the same amount of work, taking into consideration the difference in price of fuel used in either case.

This has been repeatedly demonstrated to be true.

We have said that all joints made by the electric process are butt welded. One exception to this is in the case of tires of certain grades of steel, in which case the electric welding apparatus is simply used as a heater in place of the forge. The two ends of the tire are slightly lapped, heat is produced by the electric current, as in the case of a butt weld, and when the desired temperature is reached the ends are welded together by means of hammers. Joints made in this way have proved very satisfactory.

It has frequently been asked why, in welding tires, the current does not take the course around the circumference of the tire, rather than through the divided part where it is desired to make the weld.

It is because the resistance through the long length of tire opposite the weld is much greater than through the shorter distance at the weld. Take, for instance, a tire nine feet in circumference. The clamps for this would be say four inches wide each, the distance between them where the weld is to be made two to three inches. This would leave a length of something over eight feet around the whole side of the tire, which would have to be traveled by the electric current should it pass that way. Now, the resistance through this eight feet of solid metal is very much greater at all times than through the two or three inches of metal where the weld is to be made, even with the break in the center. The result is, that as a current of electricity will always take the path of the least resistance, it would pass in such a tire almost entirely through the point of welding.

As we reduce the size of the tire, thus bringing the length opposite the weld nearer to that at the weld, we find there is a certain amount of current which will travel on the solid side. As we finally reduce the size of the circle to that of a hub band, a certain amount of electricity will pass around the whole side, and in some cases this is sufficient to heat it, but only to a comparatively low temperature; and this is found to be advantageous, as the annealing effect upon the band takes out the stiffness and makes it easier to force the ends to be welded together, when it is desired to do so.

Aside from tire and axle welding in carriage shops, many other forms of welds can be advantageously made, such as right angles, T joints, fifth wheels, step irons, etc.

Carriage rails are also welded in large quantities, favorably competing with exceptionally cheap forge work, one firm alone having during the past year made over 700,000 welds in this specialty.

When an irregular shape is to be welded, as is frequently necessary in carriage rails, etc., it has been found best to make the T, right angle, or whatever form may be necessary of a drop forging, which can be welded into the rail itself. In this way it is possible to get much greater strength than in either the forge or electric processes, where the right angle or "jump" weld is made direct.

WELDING PLANTS FOR JOBBING PURPOSES.

In many localities throughout the country there are manufacturers who are desirous of having their welding done by the electric process, and yet have not sufficient work themselves to warrant the necessary outlay.

The aggregate of work done by such manufacturers is large, and to meet this want it is proposed to start jobbing plants in different cities.

These plants will be equipped with machines of different capacities of the Universal type, and will be supplied with all necessary facilities for doing such work as may be desired in their vicinity.

In illustration of the work we have described in this paper, Messrs. Studebaker Bros. have kindly sent from the daily product of their shops samples of axles, tires and smaller miscellaneous parts, to which the attention of members of the convention is invited.

[Showing large tire.] Now, in all these specimens the burr or upset has been entirely reduced. The weld in the case of this tire, which is two by one and one-half inches, is formed here (indicating), and has been hammered down while under the welding heat. A weld of that sort would require about thirty horse power for sixty seconds. Of course, it will depend somewhat on the time required. If less time is desired, it will take more horse power. About thirty horse power would be the most economical for this tire.

[Showing buggy tire.] Of course less horse power would be required for this tire, say sixteen horse power for ten or fifteen seconds. The weld has been made at this point (indicating), and finished the same way—under the hammer.

Of course, the cost of electrical apparatus is necessarily quite high, but we have it down to a point where it certainly ought not to be beyond the ability of the carriage makers.

[Producing axle.] This is a wagon axle from Studebakers'. In this case the upset has been made in the axle at the same time the weld is made; that increased the section there (indicating), which is sufficient to allow for boring, if it is desired to do so. The weld is made here (indicating), and the clamps are moved backward, if necessary, and an upset is made.

[Producing another axle without upset.] Here is an axle of the same size without an upset. This is a regular inch and a quarter axle.

If there are any questions any one would like to ask which should have been covered by the paper, I shall be pleased to answer them.

Mr. J. B. Armstrong: Does the amount of carbon in the iron affect the welding?

Mr. Royce: In carriage work there is never such a large amount of carbon in the iron used as will render it too high to make it at all hard to make the weld. We weld easily as high as 40 carbon, and I think that will cover anything that is to be done in carriage work. If it is desired to weld a higher carbon, we have to give it some after work. We have been welding in piano work, for example, as high as 80 carbon.

[Producing a carriage rail.] There are various forms of carriage rails here. The Cortland Forging Company have an exhibit of electric welding down in the room below. This shows just how the forging is welded to the bar.

DR. GAUTRELET, of Vichy, says that a piece of cotton wool steeped in 5 to 10 per cent. solution of pyrogallic acid, inserted in the pipe or cigar holder, will neutralize any possible ill effects of the nicotine. Citric acid has already been recommended by Vigier for the same purpose, but that spoils the taste of the tobacco.

[TECHNOLOGY QUARTERLY AND PROCEEDINGS OF THE SOCIETY OF ARTS.]

ON SOME RECENT DISCOVERIES AND PROBLEMS IN THE ANATOMY AND PHYSIOLOGY OF THE BRAIN.*

By JAMES J. PUTNAM, M.D.

PREVIOUS to 1870 it was thought that the whole brain acted as a unit, the physiologists of the day believing that they had ascertained through convincing experiments that when any portion of the hemispheres, at any rate, was injured, the functions of the brain suffered a general reduction, and that localized symptoms were not produced.

If one reads the books of the date of Longet, however, indications are noticeable that this opinion was felt to need modification; and in 1861 Broca published his remarkable discovery, indicating, on the basis of post-mortem examinations, that destruction of the third frontal convolution gave rise to aphasia.

In 1870 two remarkable series of investigations were published, which initiated a new epoch in our knowledge of the anatomy and physiology of the brain. The observations of Fritsch and Hitzig in Germany were the first to see the light; but the experiments of Ferrier, which appeared soon after, had been conducted without a knowledge of what the German investigators were doing. These two series of experiments were both of them set in motion by theoretical considerations; but I shall refer to only one of these, that of Dr. Hughlings Jackson, of London, who has always been the philosopher among physicians. He said to himself that there must be parts of the brain in which the "raw materials of consciousness," the ideas of color, form, sound, motion, and the like, must lie separate from one another. He further noted the fact that when epileptic attacks occurred it was common for the spasm to begin with contractions of a few muscles—those of the hand or face pre-eminently—and then to spread to the rest of the body in regular order, and offered the hypothesis that, corresponding to the order of succession in which the different parts became involved, there would be found a mosaic of centers in the cortex of the brain. . . . Dr. Ferrier's investigations were begun in order to test this hypothesis.

It would be impossible for me to pass in detail over the wonderful series of experiments which have been made since that day, and I can only indicate their general character and general results.

In character they have consisted in stimulation of the surface and deeper lying portions of the brain by electricity and other means, and in the removal by excision, cauterization, a stream of water, etc., of different cortical areas. [Dr. Putnam pointed out on the models and diagrams taken from Ferrier, Horseley, and others, the position of the centers corresponding to the movements of the face, hand, arm, leg, trunk, etc., the area concerned in motor aphasia, the seat of vision, of hearing, etc.] If the fissure of Rolando is taken as a line of departure, running as it does across the convex surface of the brain, the motor areas may be found to lie immediately adjoining this fissure, while the occipital lobe is concerned mainly with vision, and the temporo-spheroidal lobe with hearing. The seat of the sensory functions of the skin occupies, probably, more than one place, since sensory impairment follows injury in the so-called motor area (which, by the way, is really an area for the sensation of motion performed), and also, in all probability, lesions of the so-called limbic lobe on the median surface of the brain. The so-called centers do not form a mosaic, but overlap, and the different layers of the cortex perhaps have different functions, sensory, motor, and the like; the cortex contains, also, centers for thermo-taxis and respiration, and, in short, for all the functions of the body. The anterior lobes of the brain do not seem to be much concerned in motion or sensation, and even when they are badly damaged, as happened in the celebrated "Crowbar Case," the patient may retain the ordinary functions of life. At the same time it is probable that, since this part of the brain increases in size as we ascend the animal scale, some of the most important mechanisms for the higher intellectual life reside in it.

[The next subject taken up was the practical clinical results of these discoveries, and the general character of the surgical operations for tumors, abscesses, and the like, was described. The theory that epilepsy may be due to a localized cerebral lesion, and therefore susceptible to cure by cortical excision, was discussed, but on the whole this theory was discarded, except for cases of definitely localized irritation.]

As to the question how the brain acts, we find ourselves forced to readopt, in some measure, the views of the older physiologists, though using them in a new sense. In other words the essence of brain activity is in the arrangements that exist for the association of the functions of the different parts on an enormous scale, and the bulk of the brain is made up of associating tracts of nerve fibers, which lie packed together so closely that on cross section the surface appears as homogeneous as a piece of cheese. If we go down to the lowest vertebrate known, the *amphioxus*, or lancet fish, we find a brain that is scarcely larger than the spinal cord, of which it forms the extremity. Such an animal as this gets on about as well without his brain as with it, the spinal cord being sufficient for life and most of its functions. As we ascend in the scale, we find the functions of the brain becoming steadily more important, and the spinal cord taking a less and less independent place. Even the dog, however, will bear the loss of the hemispheres of the brain fairly well, if sufficient time is allowed him to gradually accustom himself to do without them [Goltz]. In the lower vertebrates the functions of vision and sight are rudimentary, and serve only to guide instinctive acts which result quickly in motion. In the higher animals these functions occupy a relatively enormous area, and are concerned in every thought of the mind, either directly or through symbols. We can perhaps study out the general mode of action of the brain the best by taking one example, the function of language.

When the child learns to speak, his first effort is usually to reproduce a sound which he hears, connecting it very early, though not necessarily at first, with the sight of an object of some more or less complicated idea. His next step is to apply his sound or word to a class of related objects or ideas, the word "bread," for example, being often used for different kinds of food; and then to discover that this expression has been outgrown, and that a differentiation is needed.

However far we trace this process we find the same factors at work, and however complicated language becomes, we test its degree of perfection by the richness of its individual symbols and the differentiation in meaning of which its symbols admit. I beg you now to note that the richness of meaning of a given symbol implies a corresponding co-ordination or focusing of a correspondingly great number of cerebral functions. Think, for example, what such a word as "home" or "patriotism" is to the cultivated or fine person, compared to the rude or savage person; or take such a word as "justice," and consider what it means to the primitive man, who knows no one beyond his family or tribe toward whom he is called upon to show consideration, and what it means to the true philanthropist, who regards himself as akin to all the world. To this increased wealth of meaning of the word an increased co-ordination of cerebral processes corresponds. The necessity for the co-ordinated action of the various parts of the brain in speech is shown not only by the study of word symbols, but by studying the derangements of speech known as aphasia. [Dr. Putnam then pointed out on the model the way in which lesions of the motor speech area on the one hand, and the sensory and visual area on the other, and the tracts that unite them, may interfere with the speech function.] When we speak a sentence, that sentence rings in the inner ear (auditory cortical area) before it is uttered, and without this it cannot be spoken correctly. The different forms of aphasia occur to a slight degree among healthy persons, under the influence of fatigue, embarrassment, and the like. The fact that we are not conscious of all this intricate brain action which precedes some overt act or utterance does not show that it is not there. Consciousness has been described by one writer as like the little ripples that are seen on the surface of the sea, which strongly attract our attention, while we hardly recognize the existence of the great waves moving underneath.

Two general facts of recent discovery are of interest. One is that, in spite of these intricate arrangements for associated activity of the different parts of the brain, no two ganglion cells are actually united. The fibers grow out from each cell, forming long processes which terminate in the neighborhood of other cells, but do not actually enter into connection with them. So it would seem that the associated action of the different ganglion cells must take place by a process something like induction.

Another point of interest is that it has recently been discovered by Mr. Hodge, of Clark University, that when ganglion cells enter into activity demonstrable changes take place in them, leading to a rarefaction of the protoplasm and a condensation of the nucleus.

Finally, the conclusion may be insisted on strongly that a study of the evolution and functions of the brain leads us irresistibly to the conclusion that it is intended that in the "redistribution of force for useful ends" all the activity of the brain should result in definite acts, just as much as the nervous arrangements which govern the action of the heart or the other viscera, and the brain should eventually give back all the force that it receives, as the cushion of the billiard table throws back the ball.

If a great deal of our cerebral activity seems to be a contrivance for luxury or idle pleasure, this is because we are not living up to our possibilities. The best educational developments of the present day are those that teach efficiency combined with the power of associating and focusing for a given end the largest possible number of associations and ideas.

A large class of nervous disorders to which modern society is prone are those which come with an undue development of the functions of perception and sensation over those of effective action. A man must not be a narrow-minded Philistine, on the one hand, but on the other, he must not be a sentimentalist. When efficiency is secured at the expense of broadmindedness, we have the narrow man, whose thought symbols are meager in their content. On the other hand, effective action is, after all, a higher function than simple appreciation. Thus the function of speech is a higher function than that of simply understanding, provided that the subject matter in both cases is the same; and so in the neurasthenic and hysteric brain we find a rank overgrowth of sensibilities which cannot be utilized in action, and to counteract the tendency toward this condition is one of the highest functions of education.

* Abstract of a paper read February 14, 1892.

GYMNASTIC ANATOMY.

A LECTURE on physical education was delivered recently in the Gymnasium of the Royal Military Academy, Woolwich, by Surgeon Major Deane, of the medical staff, of which the following is an abstract, as given in the *Lancet*. The lecture, which had been previously given at the Royal Military College, Sandhurst, was in itself well worth listening to, but it excited a good deal of popular interest—as far as the cadets were more especially concerned at any rate—owing to the fact that Sandow, the strong man, was in attendance and afforded in his person a practical illustration of what can be done by physical training in an individual naturally of powerful build—in fact, an object lesson in gymnastic anatomy. The proceedings were under the auspices of Colonel Fox, the inspector of gymnasia at Aldershot, and there was, it need scarcely be added, a full attendance. The lecturer commenced by giving various instances in ancient, mediæval and modern times of men why were characterized by their superior development of both physical and mental qualities, ending by citing the present prime minister, "as not only a man of powerful intellect but as a hewer of trees." He then went on to explain that nature had given us a certain amount of capital or reserve on which we could draw, and added that this might be more clearly represented by assuming that our personal equation was 1.

This reserve force was continually being drawn upon, and could only be maintained by good food, sleep and healthy exercise both of mind and body. He pointed out that physical exertion and exercises undertaken for strengthening and developing the muscles were not without exercising a favorable influence also in developing the mind, and among other illustrations remarked that it was commonly recognized that the more exercise a schoolboy took, the more fresh and quick he became in his studies. Be this as it may, however, and in a sense and within limits it is undoubtedly true, the lecturer went on to say that if England was the most athletic nation it was also the worst physically trained one, for young men took up such games as cricket, football, racquets or running, which collectively were very good indeed in their way, but he pointed out that, taking them separately, they all tended to develop only certain parts of the body. In order to avoid this partial development the first thing to be noticed in studying the human frame is, that it is made by nature to stand erect, from which we might infer that all exercises should be performed in that position on the ground on which we stood, and not above it, as in so many of the exercises provided in gymnasia in England. Sandow's development had been attained by constant and systematic use of the muscles, and especially by the employment of 5 lb. dumb bells, each exercise being designed to increase the power of some particular muscle or group of muscles. Sandow had modeled his system of training on that in fashion with the Greeks and Romans. He had not employed any modern gymnastic apparatus, but had attained his marvelous muscular development mainly by the use of light dumbbells in connection with observations on the anatomical arrangement and disposition of his muscles. The lecturer then asked Sandow to perform certain feats and exercises in illustration of what had been advanced. From this point to the conclusion the proceedings became in a physiological and anatomical sense very interesting and instructive, for rarely indeed can the various muscles be seen by being put into action in the living body as definitely and precisely as if they had been laid bare by a dissection in a dead one as was the case in Sandow's exhibition of them. Stripped to the waist, he was able to demonstrate by different movements how great was the command he had over various muscles. Clasping his hands behind his head, he was able to make his biceps rise and fall in time to music. Walking round the audience he displayed various muscles in action as they were separately named. By putting his hand behind his back in such a position as to cause contraction of the deltoid he can raise that muscle to a degree that makes the shoulder look out of all proportion to the rest of his body.

The development of the flexor and extensor muscles of the upper extremities, especially of the triceps, was also noteworthy. He can flex or bend his wrist to such an extent that a vertical line drawn from the knuckles will fall on the region of the muscles of the forearm. The intimate physiological connection between the terminal nerves distributed on the skin and those of the muscles beneath, as well as the contractile power of the muscles themselves, are readily manifested; and the normal reflexes should be capable of being easily demonstrated. Sandow applied the hands of some of the bystanders to the skin over the chest walls and other parts of the trunk of his body, with the result that a young fellow described the sensation as being like that of "moving your hand over corrugated iron." Standing in the center of the room, he showed his maximum and minimum chest measurement. After an efforted expiratory act, aided apparently by the pressure of his arms against the ribs laterally, a difference of twelve inches is caused by deep inspiration and forcible action of the inspiratory muscles.

When he fully inflates his chest and "sets" its muscles his arms form an angle of about 40° with his body, owing to the size and prominence of the muscles under the arm and toward the back of the shoulder and those of the lateral aspect of the chest. The pectoral and serrati muscles are very noticeable. Taking two packs of cards together he attempted to tear the two packs—104 cards—in twain, and after spending about ten minutes in his efforts to do so he succeeded in accomplishing his purpose, affording at the same time an indication of the great muscular strength of the hand and wrist. He failed in doing this at Sandhurst. In order to illustrate the development of the muscles of the back he took a short length of circular India rubber of about an inch or more in diameter and fitted with handles. This, on being previously passed round the audience, could hardly be stretched by four cadets pulling at each end. Sandow, however, taking hold of the handles and turning his back to the audience, stretched the India rubber across the back of his neck until his arms were extended at right angles to his body. The action of the muscles of the back caused them to look, as it was remarked, like snakes coiling and uncoiling themselves under his skin. In order to show his weight-lifting power he used a barbell weighing 270 lb., which one of the strongest sergeants of the academy had only succeeded in lifting from the ground by the use of his body as well as his arms.

Taking the barbell in the center, Sandow allowed it to swing, as it were, by its own weight across his shoulder, from which position he slowly raised it upward to arm's length above the shoulder. An arrangement was then shown for exercising the adductor muscles of the leg. It consisted of two upright posts and pieces of India rubber, which are hooked to them and to straps which fasten round the leg just above the knee. The performer sits in a chair between the posts and tries to press the knees together by extending the India rubber. A cadet who had tried the apparatus could with great effort just do this with three pieces of India rubber connecting his legs with the posts. Sandow, having attached one more piece of India rubber on each side, which was all that was available, opened and closed his knees with the utmost ease and without any apparent effort. With the view of showing his gymnastic agility, Sandow very neatly turned a somersault at the close of the performance.

His personal equation, as compared with that taken on the previous assumption, may be represented as 50. It is scarcely necessary to add that, with cadets for an audience, Sandow did not lack applause and that there is at present a "great run" on all the light dumbbells at the Royal Military Academy. The demonstration is, as we have said already, chiefly interesting from an anatomical and physiological point of view, and we have not attempted to discuss the merits

of this system from the standpoint of military training and hygiene. The advantages of outdoor exercises and sports—in the way of fresh air, emulation, pleasurable excitement and variety—over more systematic and exact methods of physical training need not be stated, for they are obviously on the side of the former.

HOW TO LIVE WHERE THERE IS MALARIA.

IN his recent work on "The Climate of Rome and the Roman Campagna," Professor Tommasi-Crudeli devotes a valuable chapter to the subject of the preservation of human life in malarious countries. Our readers will be glad to have in a compact form the views of so eminent an authority on this very important and interesting topic. We must be content to admit for the present we have no precise knowledge of the nature of the malarious poison or of the means whereby it can be extirpated from the soil of an infected locality. That the poison inheres in the soil; that it is under the influence of season, temperature and rainfall; that it is excited to fresh activity by all measures involving the disturbance of earth long left quiescent; that its ravages have been much reduced by drainage, by the conversion of naked soil into meadow land, and by the erection of houses and laying down of paved streets—these facts are certain, and almost exhaust our knowledge on the subject.

Professor Tommasi-Crudeli points out that the traditional precautionary measures long adopted in malarious countries have had two ends in view, viz., to reduce as much as possible the quantity of the malaria ferment which enters into the system through the air breathed and to prevent a lengthened abode of the same in the system. The first point is sought to be achieved by avoiding agricultural operations during those hours at which the malarious influence is most potent, viz., about sunrise and sunset; hence, according to the writer, is really explained the much misunderstood dictum of the ancient Sybarites: "If you wish to live long and well, do not ever see the rising or the setting sun." Another point of the greatest importance is to avoid breathing the air in close contact with the soil, as it can be shown that the malarious poison rises only a short distance in a vertical direction. Thus in the Pontine Marshes, an intensely malarious region, platforms four or five meters high are erected, upon which the people sleep in the open air with comparative impunity. In Greece, the jungles of the East Indies, and Central and Southern America, similar devices have been adopted with beneficial results. Another mode of eluding the malaria-laden air in close contact with the ground is to construct the dwellings in such a way that when the door is shut the internal atmosphere is renewed only by the strata of the local atmosphere which are near the roofs of the houses. This is managed in some localities by so arranging that the only opening in the outer walls is the door, and all the windows open on an inner yard at a higher level than the ground floor of the house.

It is advisable also to keep the windows of the houses closed in the morning and during the early hours of the evening, especially if any excavations should be going on in the neighborhood. Care should be exercised regarding the effects of placing vases of flowers in occupied rooms; either these should be entirely excluded from houses when malaria is rife or the utmost vigilance should be taken to secure thorough ventilation.

The above measures all aim at preventing the reception of the malarious poison into the system or of reducing the amount received. Other measures are directed to preventing the germs, already absorbed, from remaining in the human body for any length of time. These measures, according to Professor Tommasi-Crudeli, all resolve themselves into expedients for maintaining in an active and regular condition the circulation of the blood. Everything that tends to keep the secretions healthy and active promotes the elimination of the malarious poison and reduces the probability of its effecting destructive changes in the body. The principal indications are to maintain constitutional vigor by good nourishment, the moderate use of wines and spirits, and to avoid all disturbance of the system from variations of temperature. Hence warm clothing, even in the hot season, is indispensable.

The difficulties regarding the above preventive measures are the time, expense, self-restraint and inconvenience involved in carrying them out. Acclimatization comes to our aid; not, however, acclimatization of the individual, but of the race. "This power of constitutional resistance has been proved to be hereditary, and the repeated selections, caused by malaria in each generation, have conduced to the eventual increase of the resisting powers of the race, and that to such a degree as to enable it to found powerful colonies in unhealthy sites, such as in Italy were those of Selinunte, Agrigentum, Sibaris, Pæstum and Rome."

The chief remedies that have been used to combat malaria are quinine, arsenic, eucalyptus, salicylates, the fruit of the lemon, etc. The good effects of quinine are, of course, unquestionable. Its anti-malarious influence is, according to Professor Tommasi-Crudeli, rapid but fugitive. Quinine is, unfortunately, rather expensive and tends after a time to disturb the digestive organs and the nervous system.

Arsenic the writer regards as a remedy of the very highest value, especially as a prophylactic. He has instituted extensive experiments among the properties of the landowners of Tuscany, Rome, Puglia, and Sicily, and among the workers on the Roman and southern railways with encouraging results. Dr. Ricchi, the chief medical officer of the southern railways, experimented in the year 1883 upon seventy-eight persons in the district of Bovino, where malaria is very virulent. He divided them into two categories, one of which only was subjected to the preventive system by means of arsenic.

The result was that the great majority of those who took no arsenic (we are not told the precise number) had violent attacks of fever, while of those subjected to the arsenical treatment thirty-six escaped entirely, while the remaining three had only slight attacks. Other experiments were not less satisfactory, and some cases of failure were attributed to the arsenic having been administered in a non-assimilable form.

Professor Tommasi-Crudeli has no faith at all in the alleged anti-malarious influence of the salicylates, and attaches hardly any greater value to the use of eucalyptus. He also disputes the alleged beneficial results said to have attended the planting of eucalyptus trees in malarious regions. He thinks much more highly of a popular remedy widely employed in many parts of Italy, Greece, Arabia, the West Indies, etc., viz., preparations of the lemon tree. The most active preparation is said to be a decoction of the whole lemon fruit, and remarkable results are claimed for this cheap and simple remedy.

The net result of Professor Tommasi-Crudeli's experience would seem to be that hygienic and dietetic measures are of the greatest importance in dealing with malaria, that arsenic has a true prophylactic influence, and that quinine and a decoction of lemons are the most valuable remedies during the actual attack.—*Lancet.*

THE CHIMPU.

THE chimpu is a reckoning device still employed in some remote parts of Peru and Bolivia. Mr. T. Ber, of Lima, has recently sent us a drawing of it. It consists essentially of a certain number of cords tied together at one of their extremities and along which slide small perforated balls. The cords are of different colors and the balls are made of the shells of various fruits. These balls can be strung all at the same time upon all the cords or upon a certain number only.

The Indian thus has a means of creating for himself categories of juxtaposed numbers corresponding in our processes to as many columns as there are cords in the apparatus. If, as it happens, moreover, the native calculator decides that the balls strung a single time shall represent units, that those through which two cords pass shall equal tens, etc., he will be able to represent any numbers whatever. He will figure, for example, as in Mr. Ber's drawing, the figure 4,456 by stringing 6 balls on one cord, 5 on two cords, 4 on three cords and 4 on four cords. The little instrument once tied at the lower extremity, as it was previously at the upper, will indefinitely preserve the quadruple number which will have thus been confided to it.

We think we see in this curious reckoning device of the present Indians a survival and a simplified adaptation of the old *quippus* or cords with knots of various colors that took the place of writing and numeration among the ancient Peruvians. It is true that the

THE CHIMPU.

chimpu is at present decimal or nearly so (the ten is easily exceeded on the first cord), but we do not know what it was of old. Moreover, we know absolutely nothing of its history, and Mr. Ber himself asserted in 1878 that he had met with no vestige of the ancient numerical cords in Peru. It would be interesting to know what tribes it is that have preserved the use of the chimpu, and what are the amplitude and variety of the operations that the Indians are capable of executing upon this little apparatus. We only know that the chimpu figured by Mr. Ber expresses a number of four figures, and we consequently suppose in the Indian who mounted it a certain breadth of calculation quite rare among true savages.—*La Nature.*

MILLIONS OF CATTLE DYING IN AFRICA.

WITHIN the past year and a half a terrible epidemic has destroyed millions of the cattle of Africa and inflicted a crushing blow upon the pastoral tribes. The plague of thirty-five years ago worked great destruction, but it cannot be compared with the present affliction. It would be of incalculable benefit to the natives if some means were found to arrest the progress of this virulent disease. Thousands of lives among the pastoral tribes would be saved if the destruction which is carrying off their cattle were stopped. No competent person has yet reported upon the nature of the plague and its remedy. The symptoms are debility, rapid wasting away, and refusal of all food. The plague has also practically exterminated all the buffaloes in regions where they once roamed in great herds.

The results of the epidemic have been most disastrous in all the cattle-raising countries of the Soudan, from the regions south of the big northern bend of the Niger River for 2,000 miles east almost to the Indian Ocean. The first news concerning the plague came in a letter written by Capt. Monteil, at Kano, on Jan. 6 last year. He said he first observed the plague in the district of Liptako, west of the Niger River, and that he could say without exaggeration that not one animal in a thousand for 500 miles along his route to Sokoto escaped. He lost his baggage animals, and for a time was hardly able to advance.

Capt. Lugard, who has recently returned to England, reports that the cattle-raising tribes between the Albert Nyanza and the Indian Ocean have suffered greatly from the plague. The Wanilyka, north of the Usambara mountains, within two or three days' march of the east coast, have lost all their cattle. Flocks of goats now form their only wealth. On the great Masai plateau, further west, 6,000 ft. above the level of the sea, the warlike Masai, who have lived upon the milk and flesh of their herds, have lost their cattle. This misfortune, Capt. Lugard says, has greatly tamed their arrogance.

Usoga, north of Victoria Nyanza, formerly contained great herds of cattle, but now all are gone. The Wahuma, a people west of Usoga, were exclusively pastoral, living like the Masai upon their herds. Now that their cattle have been wholly wiped out the people have died in great numbers, and those who are left are dependent upon the tillers of the soil near them for a scanty subsistence. "They are themselves learning slowly to cultivate the fields," says Capt. Lugard, "but vegetable food is unnatural to them, and their gaunt and half starved frames, almost invariably covered with skin disease, attest the hardships they are undergoing."

Most of the pastoral tribes have little knowledge of agriculture, and their herds are almost their sole source of wealth. A greater misfortune than the loss of their cattle could scarcely befall them. It is certain that since explorers began to visit inner tropical Africa no affliction has ever come upon the natives so calamitous and widespread in its results as the present cattle plague. The epidemic is reported to be still spreading north and south of its main route across the continent.—*N. Y. Sun.*

GALILEO GALILEI AND THE CELEBRATION AT PADUA.

ALTHOUGH Galileo began his career as a teacher in Pisa, and occupied for three years the chair of mathematics there, and was inscribed until his death in the list of the teachers of that university, nevertheless the University of Padua was the one to which from the beginning he had aspired, and in which he exercised with the greatest efficiency his powers as a man of science and a lecturer. Now the university and citizens of Padua desire to celebrate the tercentenary of the day on which he delivered his first lecture.

When elected by the Venetian republic to the chair of mathematics on September 26, 1592, he asked to be permitted to delay the beginning of his lectures in order to prepare his inaugural oration, and to attend to some domestic duties which required his presence in the country; thus it was December 7 when he first occupied the professorial chair. This date is confirmed by a letter, written from Padua to Tycho Brahe, and published by the latter in his celebrated "Astronomiæ Instauratæ Mechanica," and Galileo's chair is among the most precious relics preserved by the ancient and famous university. A week later he began regular lectures, which he continued to give for eighteen years.

In the ancient archives of the university the rolls of the time when Galileo taught are in a great measure preserved, and from these we learn that, in accordance with what was prescribed by the statutes, he alternated astronomical teaching with that of Euclid and the mechanical questions of Aristotle.

The didactic activity of Galileo was not altogether confined to public teaching; it was extended, in conformity with the prescriptions of the statutes, to private teaching. How much influence he exercised in this manner is easily seen from his autographic records which have come down to us. The importance of these private lessons will appear all the greater when we reflect that they dealt not only with the subjects discussed in public, but with matters connected therewith. From contemporary documents we perceive with what precision all such subjects were taught by Galileo: the use of the geometrical and military compass, fortifications, Euclid, perspective, mechanics, geography, arithmetic, geodesy, and cosmography. As to the students, they were for the most part foreigners, namely, Poles, Germans, Danes, French and Flemings. In the lists of private scholars we find an "illustrious Englishman"—very probably Richard Willoughby, who was vicar of the university of law and councilor of the English nation. In his honor a stone on the wall of the university is still preserved, and, a still greater honor, a copy of the famous "Difesa" is dedicated to him with Galileo's autograph. Two Scots should also be particularly mentioned as among Galileo's pupils; these were John Wodderborn, who wrote a confutation of the libel of Horky against Galileo, and dedicated it to Henry Wotton, the English ambassador at Venice; also Thomas Segget, councilor of the Scots nation, in whose "Album Amicorum," now in the Vatican library, there is also an autograph of the great philosopher. It was Segget who received from Kepler a copy of Galileo's "Sidereus Nuncius," and who in the appendix to the "Narratio" of the same Kepler published the epigrams containing the famous "Vicisti Galilaee."

Besides the ordinary public and private lectures, Galileo held in the university some special public lectures, of which we may mention those upon the new star of October, 1604, and those in which he announced his astronomical discoveries.

Every one tried to render Galileo's stay in Padua as pleasant to him as possible. His freedom in teaching was absolutely complete, and the strong arm of the Venetian republic defended the professors of the university from the power of Rome. In Padua, from the first, Galileo was received with the greatest kindness; he found many faithful friends both in Paduan society and among the Venetian patricians. His salary was repeatedly increased, so that, after the presentation of the telescope, it rose to thrice the amount conceded to his predecessors. Galileo came to Padua at the age of twenty-eight and remained there during the eighteen years which were the best of his life, those in which he showed the greatest scientific fertility, and in which he prepared the way for all his future labors. We have now reached the completion of the three centuries since Galileo began his teaching in Padua, and the university naturally considers that the anniversary should not be allowed to pass without honorable notice.

It is fitting that a celebration relating to the work of a man of science of the highest rank should have a truly national character. The King of Italy has therefore associated himself with the movement; and the

universities, the polytechnic institutions, and the most celebrated academies of the world have been invited to send delegates. Already the universities have in great number responded to the appeal. Mr. J. Norman Lockyer will represent the Royal Society of London, and Mr. George Howard Darwin the University of Cambridge.

As once scholars from every part of Europe came to Padua to hear the celebrated master, so now from every part of Europe the most celebrated come to honor his memory.

ANTONIO FAVARO,
Director of the National Edition of Galileo's Works.
—*Nature.*

THE EGYPTIAN METHOD OF TRANSPLANTING TREES, B. C. 1600.

WE are indebted to Mr. W. Lee, of the firm of Charles Lee & Son, the Royal Vineyard Nurseries, for the following interesting communication:

Miss Amelia B. Edwards, in her valuable book, "Pharaohs, Fellahs, and Explorers," furnishes an account of the transport of trees 3,500 years ago, that proves once more the truth of Solomon's assertion, that there is nothing new under the sun.

Queen Hatasu, whose throne is now in the British Museum, reigned at Thebes as sole monarch for about sixteen years. The most remarkable event of her reign was the dispatch of a fleet of sea-going ships to the land of Punt, a region identified with that part of the Somali country which is situate on the eastern coast of Africa, bordering the Gulf of Aden.

The fleet is conjectured to have made its way down the Nile from Thebes to Cairo, thence through the Sweet Water Canal to the Bitter Lakes, and through the older Suez Canal into the Red Sea.

There are a great number of wall paintings, showing the expedition, but our first will be taken from the landing in Punt. The ancient draughtsman, in one of the very few known examples of Egyptian landscape art, has carefully depicted for us the characteristic scenery (Fig. 1) of the unknown country to which the squadron has made its way. The ground is flat and thickly wooded, the conical huts of the inhabitants being built on piles, and approached by ladders. A cow reposes peacefully in the shade of a tree to the right, and a bird, known by its characteristic tail feathers as the Cinnyris metallica, wings its flight toward the left. Of the five trees represented, two are conventional renderings of the date palm. The trunks and branches of the other three are most carefully drawn. An inclosing line carried round each indicates the outline of the foliage, the details of which are left to the imagination. We are here on the banks of the river; the three last named trees exactly reproduce the odoriferous sycamore, which grows on the borders of rivers. The water is painted green, which may be taken to indicate a tidal river, green being the Egyptian color for sea water and blue for fresh water. The fishes, too, are not the fishes of Egypt.

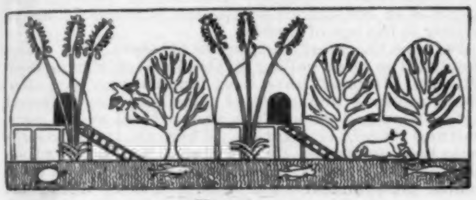


FIG. 1.

FIG. 2.

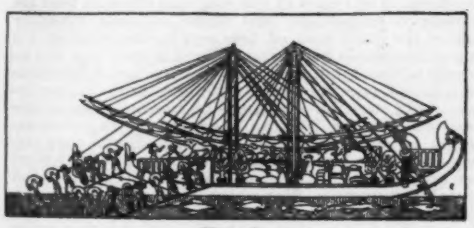


FIG. 3.

FIG. 4.

ANCIENT EGYPTIAN MODE OF TRANSPLANTING TREES.

The tableaux form a continuous scene (Fig. 2). In our next we see the Egyptian sailors carrying half grown saplings which have been taken up, with a ball of earth about the roots, and are being transported in baskets slung upon poles, each pole carried by four men. These are accompanied by natives of Punt, some carrying large logs of ebony, others leading apes. A running commentary of short inscriptions is interspersed here and there between the figures. "Stand steady on your legs, Bohu," says one of the bearers. "You throw too much weight on my shoulders," retorts Bohu.

Over the saplings which are being carried in baskets is inscribed Nehet Ana; that is to say, the sycamore of Ana. Elsewhere we see the full grown trees. The trunk is massive, the leaf is a sharp-pointed oval, and at the junction of the trunk and the larger branches are seen little copper-colored lumps of irregular form, representing the resinous gum which has exuded through the bark.

A passage in Pliny shows that this tree, the odoriferous sycamore, can be none other than the myrrh tree, whose gum was brought by the ancients from the so-called land of the Troglodytes. According to the old naturalist, the myrrh tree is found "in many quarters of Arabia; also there is very good myrrhe brought out of the islands; and the Sabeans passe the seas and travell as far as to the Troglodites countrey for it. The plant groweth ordinarily five cubits high, but not all that length is it smooth and without prickes; the body and trunk is hard and wrythen; it is greatest toward the root, and so ariseth smaller and smaller taperwise. Some say the bark is smooth and even, like unto that of the arbute tree; others again affirm that it is prickly and full of thorns. It hath a leaf like to the olive, but more crisp and curled, and withall it is in the end sharpe pointed like a needle. The myrrhe trees are twice cut and launced in one year, the slit reacheth from the very root up to the boughes, if they may bear and abide it."

Further on he says that of all the wild kinds of myrrh trees, "the first is that which groweth in the Troglodites countrey;" and this, "the Trogloditike myrrhe, they chuse by the fattinesse thereof, and for that it seemeth to the eye greener. The best myrrhe is known by little peeces which are not round; and when they grow together, they yeeld a certain whitish liquor which issueth and resolveth from them, and if a man breake them into morsels, it hath white veines, resembling men's nails, and in tast is somewhat bitter."

That the ana was undoubtedly the resinous gum of the myrrh tree is confirmed by the passage from Pliny, which describes it of a green color, the green ana being constantly named in Egyptian inscriptions as the most precious and desirable kind.

In the next illustration we see the Egyptian sailors, some carrying the saplings (Fig. 3) in baskets slung from poles as before, others laden with big jars, and all hurrying on board along inclined planks. The decks are already piled high with their precious cargo, among which may be observed three large apes, who make themselves perfectly at home. Slung to the mainmast of the nearest vessel a harp is depicted, of a shape which may even now be seen in the hands of native musicians in Cairo and other large towns. The captain stands on the platform at the prow, issuing his commands, and, small as is the scale, the very natural action of the man in front of him, who shouts the order with his hand to his mouth, must not be overlooked.

Our last tableau shows a row of sycamore saplings in tubs, with (Fig. 4) an inscription, stating that "thirty-and-one growing trees of the ana were taken at Punt to the holiness of the god Amen. Never was there seen the like since the world began."

The illustrations and text are derived by Miss Edwards from Mariette Bey's work, "Deir-el-Bahari," being a temple immediately across the Nile, opposite Karnak.—*The Gardeners' Chronicle.*

THE LATE ERUPTION OF PANTELLERIA.

IN October, 1891, a considerable sensation was produced among the inhabitants of Pantelleria and the neighboring islands by a report that a submarine eruption had taken place within a short distance of the Pantellerian shores, and that a new island had been thrown up by the seismic forces.

As usual, the reports greatly exaggerated the real facts of the case, and it was not until many months after, when Prof. Ricco published a detailed account of the alarming phenomena, that the public were afforded the means of judging of the nature and actual extent of the outbreak. Referring to this subject in the current issue of *Neptunia*, Sig. Padovan gives some interesting details of the report of the Italian seismologist, in the course of which he gives us the most salient features connected with the outbreak. Prof. Ricco arrived at Pantelleria on the morning of the 22d of October; that was about five and a half days after the first symptoms had manifested themselves. Immediately after landing he collected all available information relating to the various phases of the disturbances of the preceding days, after which he proceeded to the crater lake Il Bagno and made an examination of its profile. The shocks of earthquake which accompanied the submarine phenomena had been severely felt by the Pantellerians, and were clearly evidenced in a fracture which was found running in a southeasterly direction from the edge of this old crater for a distance of about fifty meters. After having thoroughly surveyed the island, the professor proceeded in the steam launch Bausani to the scene of the eruptions. Jets of steam and large bombs of considerable size and consisting of a black scoriaceous pumice were being ejected in all directions to a height of several meters.

Many of these blocks on reaching the surface of the sea exploded, throwing out jets of steam in all directions, while others exploded with a loud report and gave rise to a strong smell similar to that of pyric powder. The temperature of these blocks was considerable, often being as much as 415° C. The professor's explanations for the formation of these bombs are of so much interest that we insert them here in full. The melted lava, says the professor, while rolling down the sides of the submarine crater probably inclosed considerable quantities of the water in which it moved. Then, as the melting point of the lava is higher than 1,000° F., the water thus imprisoned must remain in a spheroidal state, *i. e.*, liquid without passing into steam. But on the lava cooling, the temperature falls also in the inside and the inclosed water is then vaporized, and an enormous pressure of steam is exerted. As it is probable that under these conditions the lava may preserve much of its original plasticity, therefore, when the water is converted into steam, the lava probably expands. A vacuum is thus created and the bomb formed, being rendered lighter than the volume of water which it displaces, rises to the surface. During its ascent, however, the hydrostatic pressure of the sea water diminishes, and at a certain point, especially at the surface, where the pressure suddenly diminishes, the tension of the inclosed steam exceeds the outside pressure and an explosion results, in the course of which steam and fragments of pumice are hurled to considerable distances in the air, and the peculiarly smelling gases are diffused through the atmosphere. Alluding to the causes which gave rise to the eruption, Prof. Ricco observes that on the day when the eruption broke forth (October 17) the sun and the moon were nearly opposite to one another and in a line with the meridian of Pantelleria.—*The Mediterranean Naturalist.*

OUR MOLTEN GLOBE.

THE existence of volcanoes, geysers, and hot springs irregularly scattered over the whole surface of the globe, and continually ejecting molten rock, ashes, mud, steam or hot water, is an obvious indication of some very widespread source of heat within the earth, but of the nature or origin of that heat they give little positive information. The heat thus indicated has been supposed to be due to many causes, such as the pressure and friction caused by contraction of the cooling crust, chemical action at great depths beneath the surface, isolated lakes of molten rock due to these or to unknown causes, or to a molten interior, or at least a general substratum of molten matter between the crust and a possibly solid interior. The first two causes are now generally admitted to be inadequate, and our choice is practically limited to one of the latter.

There are also very important evidences of internal heat derived from the universal phenomenon of a fairly uniform increase of temperature in all deep wells, mines, borings or tunnels. This increase has been usually reckoned as 1° F. for each 60 ft. of descent, but a recent very careful estimate by Professor Prestwich, derived from the whole of the available data, gives 1° F. for every 47·5 ft. of descent. It is a curious indication of the universality of this increase that, even in the coldest parts of Siberia, where the soil is frozen to a depth of 620 ft., there is a steady increase in the temperature of this frozen soil from the surface downward. Much has been made by some writers of the local differences of the rate of increase, varying from 1° in 28 ft. to 1° in 95; and also of the fact that in some places the rate of increase diminishes as the depth becomes greater. But when we consider that springs often bring up heated water to the surface in countries far removed from any seat of volcanic action, and the extent to which water permeates the rocks at all depths reached by man, such divergences are exactly what we might expect. Now this average rate of increase, if continued downward, would imply a temperature capable of melting rock at about twenty miles deep, or less.

Every mountain mass on a continent has a much larger mass projecting beneath the crust into the liquid substratum, exactly as an iceberg has a larger mass under the water than above it. Sir G. B. Airy argued that, whether the crust were ten miles or a hundred miles thick, it could not bear the weight of such a mass as the Himalayan and Thibetan plateaus without breaking from bottom to top, and receiving support by partially sinking into the liquid mass. The best experiments show that the proportionate densities of most rocks in a solid and a liquid state are approximately as ice is to water, and thus no mountain masses can be formed, whether by lateral pressure or other agency, without a corresponding protuberance forming below to keep the crust in equilibrium. It is this displacement of the denser substratum by the less dense "roots of the mountains" that leads to the total attraction of such mountains being less than they otherwise would be. The rate of increase of underground temperature would, if continued downward till the heat equaled the melting point of rock, give a mean thickness of the crust of about twenty miles. But in places where the crust is so much thicker, as it is supposed to be under mountains, the rate of increase should be much less, because the lower level of the crust in contact with the liquid substratum must always be at about the same temperature—that of melting rock. This is found to be the case; the rate of increase at the St. Gothard tunnel, where the observations were most complete, being 1° F. in eighty-eight feet, and the corresponding thickness of the crust thirty-seven miles. This is certainly a remarkable confirmation of the other observations, and of the theory of mountains being supported in approximate equilibrium by means of vast protuberances into the liquid substratum beneath.

By means of some recent experiments on the melting point and specific heat of rocks, made at his suggestion, Rev. Osmond Fisher arrives at the conclusion that the average thickness of the earth's crust on lands near the sea level is only about eighteen miles. Its density is estimated at 2·68, water being 1, and the density of the liquid substratum at 2·96.

With these new data it appears that if the melted substratum were an inert mass it would have cooled at such a rate that the crust would have attained its present thickness in about eight million years. But geologists are almost unanimously of opinion that any such period as this is absurdly too small, and that to account for the phenomena presented by the known series of rocks and their included organic remains, the very least time that must be allowed is one hundred million years. The conclusion Mr. Fisher draws from this discrepancy is, that the substratum is not inert but energetic, that is, that it is in a state of movement or circulation, convection currents continually bringing up fresh heat from below and thus preventing the crust from solidifying so rapidly as if there were no such currents. A cause of such currents is found in the friction produced by tidal action in the liquid mass, which Professor George Darwin has shown to be very great, and to be at a maximum in the central portions,

Gravity having approximately its normal value all over the globe at the sea level, it is evident that there must be some denser matter under the oceans to make up for the much less density of the water, which is at least three miles deep on the average. A very refined mathematical investigation shows that this can only be brought about by the suboceanic crust being both thinner and denser than under the continents, the denser portion being the upper layer. This distribution of matter may, it is supposed, be due to extensive outflows of heavy basalt over the original depressions forming the ocean floors, at some early period of their history.—*Alfred Russell Wallace, Fortnightly Review.*

THE PREHISTORIC RACES OF ITALY.*

By Canon ISAAC TAYLOR.

NOWHERE in the world is there such a mixture of races—such a *colluvies gentium*—as in Italy.

At the beginning of the historic period we find Siculi and Sicani in the south, Etruscans in the north, and in the center Umbrians, Latins, Sabines and Samnites, all speaking Aryan languages. At a very early time the Carthaginians made good their footing in the west of Sicily, and the Greeks established colonies in the east. Southern Italy became Magna Græcia—so that the greater Greece lay beyond the Adriatic, just as the greater Britain now lies beyond the Atlantic. The Greeks pushed their trading posts as far as Cumæ in the Bay of Naples and the Phenicians established theirs at Cære, 20 miles from Rome.

In the fourth century B. C. the Gauls poured over the Alps into the plain of the Po, establishing a Gallia Cisalpina in the north answering to the Magna Græcia in the south.

And then, when the Roman legions had conquered Italy and the Eastern world, Rome herself was overrun by the peoples she had subdued. Rome became an Oriental city. The Orontes, as a Roman writer complained, had emptied itself into the Tiber. A flood of Syrians, Jews, Greeks, Egyptians, Africans, Spaniards, Gauls and Dacians—slaves, freedmen or adventurers—poured into the Eternal City, making it a *cloaca maxima*—the universal sewer of the world. Then came the inroads of the northern hordes—Heruls, Goths, Vandals, Huns and Lombards—who rushed in to appropriate the treasures which during four centuries had been plundered from Africa and Asia. Next came the inroads of Normans, Moors, Spaniards, French and Germans, and lastly, the peaceable invasion of winter residents.

These are the races which, in historic times, have been added to the prehistoric peoples of the land.

At the beginning of the historic period we find the Etruscans established north of the Tiber, the Latins and other tribes speaking Aryan languages further to the south, and an earlier aboriginal population in the Apennines and Calabria.

In books written only 30 years ago the oldest civilization of Italy is attributed to a mysterious people, who are called the Pelasgi. We hear of these Pelasgi in Greece as well as in Italy. Those megalithic structures which still excite our wonder—the walls of Mycenæ and Tiryns, as well as those of Cortona and Russellæ—are called Pelasgic. Cære and Cortona are said to have been Pelasgic cities prior to the Etruscan conquest. We must therefore begin by asking who were these Pelasgi. The modern doctrine, it is hardly needful to say, is that the word has no ethnological significance, the name Pelasgic being merely equivalent to "ancient" or "aboriginal." The term was a term of ignorance, like the word "natives" now applied to Polynesians, Patagonians, Red Indians or Maoris. We may therefore leave the Pelasgians out of account, or, rather, try and find out what races were grouped together by ancient writers under this convenient but delusive appellation.

What we may call "the ethnological horizon" has wonderfully widened of late years. For vast periods, for many millenniums, we are able to trace the history of man in Europe. He is now proved to have been the contemporary of the great extinct carnivora and pachyderms, and to have followed northward the retreating ice sheet of the last glacial epoch. The history of these primeval races has been traced by the tools and weapons which they have left, and by the shape and character of their skulls.

Archæologists have distinguished the successive ages of stone, bronze and iron. The bronze age in Italy is believed to have commenced some 4,000 years ago. The stone age which preceded it is divided into two epochs, the Palæolithic age, or age of chipped flints, and the Neolithic age, when the flint implements were ground or polished. The Palæolithic people were utter savages, clad in skins, living in caves or rock shelters, making use of no fixed sepulchers, subsisting on shell fish or the products of the chase, ignorant of pottery, without bows and arrows, and armed merely with spears, tipped with flint, horn or bone.

Skulls which are believed to be of Palæolithic age have been found in various parts of Italy—at Olmo, at Isola del Liri, at Mentone and in some Sicilian caves. They are all dolichocephalic, or long skulls. Owing to the presence in their refuse heaps of human bones which seem to have been broken in order to extract the marrow, it is believed that these people occasionally practiced cannibalism. But their chief food seems to have consisted of wild horses of a small breed, which then roamed over Europe in immense herds. Enormous refuse heaps, consisting mainly of the bones of horses, have been found outside the caves which were inhabited by this race. In the caves at the foot of Monte Pellegrino, near Palermo, the floor is formed by a magma of the bones of wild horses, which were either stalked with spears, driven by the hunters into pitfalls or chased over the cliffs. Similar deposits have been found at the cave of Thayngen, in Switzerland, and in front of the rock shelter at Solutre, near Macon, where there is a vast deposit, the relics of the feasts of these savages, nearly ten feet in thickness and more than 300 feet in length, composed entirely of the bones of horses and comprising the remains of from 20,000 to 40,000 individuals.

The Palæolithic period must have lasted for unnumbered millenniums. Archæologists conjecture that it came to an end some 20,000 years ago, when it was succeeded by the Neolithic period, which may have lasted for some 16,000 years. At the beginning of the Neolithic age, when regular sepulchers were first used, we find savages who may probably be the descendants of the Palæolithic people, spread over western Europe. They were clad in skins stitched together with bone needles. They wore bracelets of shells, and painted or tattooed their bodies with red oxide of iron. Broca considers that this early race is allied to the North African tribes, their language probably belonging to the Hamitic class, without inflections and almost without grammar.

To us the chief interest of these people lies in the fact that their descendants may probably be traced in the present inhabitants of Sardinia and of southern Italy, as well as in some parts of the British Islands and of Spain. They are usually called the Iberian race. In the early Neolithic period we find skulls of the Iberian type all over western Europe, in Caithness, Yorkshire, Wales and Somerset, in the south of France, in Spain and Italy. This race was swarthy, with olive complexion and black curly hair; it was orthognathous, leptorhinic and highly dolichocephalic, with a low orbital index and short stature, averaging about 5 feet 4 inches. Their present descendants are found in Donegal, Galway and Kerry, in some of the Hebrides, in Denbighshire and in the counties bordering on Wales. They are also to be recognized among the Spanish Basques, the Berbers, the Kabyles, the Guanches of Teneriffe, the Corsicans, the Sardinians, the Sicilians and the people of southern Italy. Pausanius informs us that the Sardinians were Libyans, or what we should now call Berbers. Seneca says that Corsica was peopled by Iberians and Ligurians. Thucydides and Ephoros also inform us that the oldest inhabitants of Sicily were Iberians.

There are several prehistoric skulls of this race in the Kincherian Museum at Rome, and the Falerian skull in the Villa Papa Giulio belongs to the same type. These skulls are orthognathous and dolichocephalic, resembling the modern Sardinian skull and ancient Iberian skulls found in caves at Gibraltar and in Sicily.

This ancient type is still predominant in southern Italy, Sicily, Sardinia and Corsica. Professor Calori, of Modena, has measured more than 2,400 skulls in different provinces of Italy. In southern Italy only 36 per cent. are round headed, with a cephalic index* above 80; whereas in northern Italy the proportion is 87 per cent. In northern Italy less than 1 per cent. are of the extreme Sardinian type, with the index below 74; while in Southern Italy 17 per cent. belong to this type. The difference of race, as shown by the difference in the shape of the skull, may account to some extent for the difference in the existing civilization in the north and south of the peninsula.

Early in the Neolithic age, before the reindeer had withdrawn from Belgium, another race makes its appearance in Europe. They were a round-headed people of short stature, with a mean cephalic index of about 84. We first find their remains in the sepulchral caves of Belgium and central France, whence they extended to Savoy and to the Rhætian and Maritime Alps. They manufactured rude pottery; their weapons were axes of flint, carefully chipped and roughly polished, and spears tipped with bone or horn. The skull is of the same shape as that of the Lapps, whom they resembled in their short stature. Their original speech is probably represented by the Basque, and a few of their words may be preserved in mountain names of the Alpine region, such as *Cima*, "a hill," which is seen in the name of Cimiez, near Nice, of the Cima de Jazi, and of the Cevennes. They are designated as the Auvergnat, Rhætian or Ligurian race.

In the early Neolithic period we find in Italy only these two races, the dolichocephalic, or long-headed, Iberian race, who are physically allied to the North African tribes, and the brachycephalic, or round-headed, Ligurian race, allied to the Lapps and Finns. These two races inhabited the same caves together or in succession. Thus in a Neolithic cave at Monte Tignoso, near Livorno, two skulls were found, one of the Iberian type, with an index less than 71, and another of the Ligurian type, with an index of 92. In another Neolithic cave, called the Caverna della Matta, an Iberian skull was found with an index of 68, and a Ligurian skull with an index of 84. No anthropologist would admit that these skulls could have belonged to men of the same race.

We now come to the third Italian race, which may be called the Umbrian or Latin race. They spoke an Aryan language, and must be regarded as the ancestors of the Romans. They made their appearance in Europe at a much later time, probably not more than 6,000 or 7,000 years ago. They were taller and more powerful than either of the earlier races, and were orthocephalic, with an index of from 79 to 81. When we first meet with them, they are no longer mere savages, living solely by the chase, but are a pastoral people, who had domesticated the dog, the ox and the sheep, and who had invented the canoe, and even the ox wagon, in which they followed their herds over central Europe. They no longer, like the two earlier races, sheltered themselves in caves, but lived in huts made of boughs plastered with clay, and in winter in pit dwellings roofed with poles and twigs.

We can trace this race all over central Europe. We find their remains in the round barrows of Britain, but more especially in the pile dwellings which they erected in the lakes of Germany, Switzerland and northern Italy.

From southern Germany they spread to western Switzerladn, where we find the remains of their settlements in the lakes of Constance, Neufchatel, Bienne, and Geneva. These Swiss settlements began in the stone age, but were in many cases continuously inhabited from the age of stone through the age of bronze, coming down, in a few cases, to the age of iron. We can trace these people advancing gradually in civilization, at first subsisting mainly on the chase of the stag and the wild boar, afterward, as these beasts became scarce, depending more and more on their domesticated animals, the ox and the sheep, and gradually taming the goat, the pig, and the horse. At first we find them without cereals, and evidently ignorant of the rudest agriculture, laying up in earthen pipkins stores of acorns, hazel nuts, and water chestnuts; and then, after a time, growing barley, wheat, and flax, learning to spin and weave, to tan leather, and even to make boots. They are identified with the Helvetii, a Celtic people.

This race gradually extended itself to Italy, crossing the Alpine barrier either through Carniola or by one of the western passes, and occupying by degrees Venetia, Lombardy, and the Emilia, and finally, the whole valley of the Po.

When they first appear in Italy they were still in the stone age, and had domesticated the ox, but were ignorant of agriculture. Now the bronze age is believed to have begun in Italy not later than 1900 B. C., and therefore this Umbro-Latin Aryan race must have entered Italy considerably more than 2,000 years before the commencement of our era.

On arriving in Italy they built pile dwellings in the North Italian lakes, similar to the pile dwellings of Switzerland and southern Germany, disclosing much the same stage of civilization. We cannot doubt that they belonged to the same race, and this is confirmed by the close connection between Celtic and Italic speech.

In Italy, as well as in Switzerland, the pile dwellings began in the age of stone and lasted down into the age of bronze. Many of the small lakes have been converted into peat bogs, and in digging out the peat the remains of these settlements have been disclosed.

One of the settlements has been discovered in a peat moor at Mercurago, near Arona. This moor was formerly a shallow lake, in which a pile dwelling was built by some of the earliest settlers of the Umbro-Latin race. They had no knowledge of agriculture, but fed on hazel nuts and wild cherries. They had rude pottery and polished flint implements. A dugout canoe, a disk of walnut wood, which had evidently formed the wheel of an ox cart, and one bronze pin were found, showing that the settlement was not finally abandoned till the age of bronze had commenced.

Farther north, in the Lake of Varese, there are seven villages built on piles, two of them large, with numerous huts, which might almost be called towns. One of these towns belongs entirely to the stone age, exhibiting no trace of metal, but with remains of the stag, ox, goat, and pig. The other was founded in the stone age, but survived into the age of bronze, a pin, a fish hook, and two spear heads, all of bronze, having been found.

Another large pile dwelling in the Lago de Garda, opposite Peschiera, was founded in the stone age, and was in continuous occupation through the age of copper to the age of bronze.

Perhaps the most instructive of these lake settlements is the pile dwelling in the Lake of Fimon, near Vicenza. It must have been founded very soon after the Umbrians first reached Italy, and was destroyed before they had passed from the pastoral to the agricultural stage of civilization. There are two successive relic beds, separated by an interval, which shows that the earlier town was burned, and then, after a time, rebuilt. In the oldest bed there is no trace of agriculture, even of the rudest kind. The inhabitants lived chiefly by the chase, but had domesticated the ox and the sheep. The bones of the stag and the wild boar are extremely numerous, and these animals evidently formed the chief food of the people, the bones of the ox and the sheep being rare. There is no grain, and no cereals of any kind, but great stores of hazel nuts have been found, together with water chestnuts (*Trapa natans*), wild cherries, and stores of acorns. The acorns were roasted for food, as is proved by fragments adhering to earthen pipkins. Flint tools and rude pottery are found, but no trace of metal. The settlement was burnt, and after a time rebuilt. The newer relic bed contains numerous flint chips, and one bronze ax, showing that the age of metal had commenced. But the notable fact is, that at the time of this new settlement the people had passed from the hunting to the pastoral stage. Wild animals had now become scarce, bones of the stag are absent, and those of the wild boar are rare, but those of the ox and the sheep have become common. The agricultural stage had not, however, been reached when this second settlement was destroyed, the only farinaceous food being hazel nuts, cornel, cherries, and acorns. The dwellings were round huts, built of wattle, and plastered with clay. The remains of a canoe have been found.

We learn therefore that when the Umbro-Latin people reached Italy they were ignorant of metals and of agriculture, living mainly by the chase and on wild fruits, nuts, and acorns.

After the lakes at the foot of the Alps had been occupied, the population increased, and gradually extended itself southward, building pile dwellings in the marshes in the neighborhood of Mantua. The race next crossed the Po, erecting on dry land in the plain of the Emilia similar villages of pile dwellings, the remains of which are very numerous, and go by the name of *terre mare*. These *terre mare*, or "marl beds," are small knolls or elevations, rising a few feet above the plain, and are most numerous in the provinces of Parma, Reggio, and Modena. They consist of beds of brownish or dark colored earth, rich in phosphates and nitrates, and which are now used by the peasants for manuring their fields. They are plainly the refuse heaps or middens of ancient villages, which were pile dwellings erected on dry land. They vary from an acre to 3 or 4 acres in extent, and usually rise some 10 ft. above the plain, resembling the Arab villages in Egypt, each standing on its *tell*, raised above the inundation. These knolls are composed solely of the refuse of habitation, of the bones of animals, and of broken pottery thrown out from the huts, which were built on platforms resting on piles. The lower strata of rubbish belong to the age of stone, while in many cases the upper strata belong to the age of bronze. They must have been occupied for many centuries, to allow of such vast accumulations of refuse. They were protected by a square earthen mound or rampart, surmounted by palisades, like a New Zealand *pah*.

These *terre mare*, of which nearly a hundred are known, disclose clearly the civilization of the first Aryan settlers in Italy, the ancestors of the Latin race. They made mats from the bark of the clematis; they knew how to prepare and to weave flax; they even obtained amber beads from the Baltic, but they possessed

* From the *Contemporary Review*, August, 1890, vol. lviii., pp. 261-270.

* The cephalic index gives the proportion of the breadth of the head to the length, and is obtained by dividing the breadth by the length from front to back, and then multiplying by 100.

no swords, fibulæ, or rings. They had neither iron, gold, silver, nor glass. Bronze was cast, but not forged. We find strainers for preparing honey, and hand mills or querns for grinding grain, but there is no sign of bread having been baked. The vine was cultivated, but the art of making wine had not been discovered. No idols of any kind have been found. Certain earthenware crescents, supposed at one time to have been symbols used for lunar worship, prove to be neck rests, used for sleeping on the ground, so as to avoid disturbing the elaborate coiffure. The dwellings were merely huts of wattle and dab, no stone or mortar having been used in their construction. The people hunted the stag, the roe, and the wild boar, and kept dogs, oxen, sheep, goats, and pigs. They had no fowls. The ass was unknown, and it is doubtful whether they had tamed the horse. They had dishes perforated with holes, which were probably used for making cheese, but no fish bones or fish hooks have been found. They grew wheat, beans, and flax, and gathered wild apples, sloes, and cherries. Acorns were carefully preserved in jars for winter use.

These peaceful people must have inhabited the plain of the Po for at least a thousand years, probably for a much longer time, two or even three thousand years. They had advanced to the bronze age, and must be regarded as the ancestors of the Latins and the other Aryan tribes of Italy.

At some period in the bronze age they were suddenly overwhelmed by the invasion of the Etruscans, a fierce and savage race which broke in on them from the north. All their settlements were destroyed—not one survived to the iron age, which probably commenced in Italy in the ninth or tenth century B. C. On other grounds it is believed that the Etruscan invasion was not later than the eleventh century B. C. We learn from Varro that the Etruscan era began 291 years before the Roman. The Roman era began in 753 B. C., and therefore the Etruscan era dates from 1044 B. C. But it is not likely that the Etruscan era began before the conquerors had settled down into an organized state—*duodecim populi Etruriæ*, or confederation of the twelve Etruscan tribes. We may therefore, with some probability, place the Etruscan invasion of Italy in the twelfth century B. C. It may not improbably be connected with the great movement of races about this period, which began with the conquest of Syria by the Hittites, and of Egypt by the Hyksos, and ended with the Thessalian and Dorian invasions of Greece, and that consequent emigration of the older Greek tribes to Asia Minor which lies at the base of the Homeric Epos. It is possible that the Etruscans may themselves have been an Asiatic people, akin to the Kheta and the Hyksos. This supposition derives support from the similarity in the appearance of the Hittites and the Etruscans as portrayed on their respective monuments, from the old tradition which connects the Etruscans with Asia Minor, and also from the recent discovery in Lemnos of inscriptions believed to be in a language of the Etruscan type.

After overwhelming the Umbrian settlements in the valley of the Po, the Etruscans extended their dominion across the Apennines to the Arno and the Tiber. It seems probable that the foundation of Rome was due to the Umbro-Latin fugitives, who placed the Tiber as a barrier between themselves and the invaders, establishing themselves on the Palatine, as their Etruscan foes did at Veii, 11 miles north of Rome. Just as the foundation of Venice is attributed to the fugitives from the invasion of Attila and the Huns, so the foundation of Rome may be due to fugitives from the invasion of the Etruscans. This is supported by the fact that the *terra mare* and the *palafitte*, which are believed to constitute the primitive settlements of the Umbro-Latin Aryan race, are not found south of the Apennines beyond the Emilia and the valley of the Po. The Etruscan dominion and civilization endured for some 700 years. At length it fell before the invasion of the Gauls in 400 B. C., just as the Umbrian civilization had fallen before the inroad of the Etruscan hordes. And thus Etruria Circumpadana, the former Umbrian land, became Cisalpine Gaul, its possession reverting to a people who in race and language were nearly akin to its former inhabitants.

The settlements of the Gauls are recognized by the torques and the long iron swords which are found in their graves. At Bologna, in the cemeteries of the Certosa and Marzabotto, we have the tombs of the three successive races, Umbrians, Etruscans, and Gauls, all different in character, and easily to be distinguished.

Thus it appears that the fertile plain of the Po was occupied by many successive races, whose descendants may, with greater or less certainty, be recognized in the present population of Italy. We have first the Palæolithic Iberian savages, mere hunters and probably cannibals, living in caves, ignorant of pottery, whose descendants may be traced in Sardinia and southern Italy. They were followed, in the early Neolithic period, by the Ligurians, possessed of pottery, but without domestic animals. Their descendants now occupy the Rhætian and Maritime Alps. They were succeeded toward the close of the Neolithic age by the Umbro-Latin race, who lived in huts and pile dwellings instead of caves, who possessed oxen and sheep, canoes and wagons, and who gradually acquired a knowledge of bronze. In the bronze age, some time before the middle of the eleventh century B. C., they were overwhelmed by the Etruscan inroad, their villages were destroyed, and they fled southward from the invaders. Then, at the close of the fifth century B. C., the Etruscan dominion was destroyed by the Boii and other Gaulish tribes, who were in the iron stage of civilization. Finally came the conquest of the Romans, and afterward those of the Heruls, Goths, Huns and Lombards.

The people who lived in the pile dwellings in the valley of the Po, and who are usually called Umbrians, were clearly of the same race as the ancient Romans. The skull is of the same shape, the type of civilization was the same, and Latin and Umbrian were merely dialects of the same language.

Owing to the practice of cremation, genuine Roman skulls are rare, and of skulls ostensibly Roman many turn out to be those of freedmen or provincials. But, judging from the few we possess, the shape of the head was almost identical with that of the Umbrians, of the Swiss lacustrine people, and of the Celtic round barrow race of Britain. The great breadth of the Roman skull is well seen in the portrait busts of Tiberius, Nero, Vespasian, Titus, and Marcus Aurelius.

That the Romans were originally in the same pastoral stage of civilization as the Umbrians is shown by the fact that the words for money and property, *pecunia* and *peculium*, are derived from *pecus*, cattle; while the ox, which appears on some early Roman coins, may indicate the fact that the ox was the standard of pecuniary value. The hut urns found in the ancient cemetery of Alba Longa show that the Latins at first lived in huts like those of the Umbrians. The *ædes Vestæ* in the Forum, the most venerable relic of early Rome, was originally a hut of wickerwork and straw, and so was the *casa Romuli* on the Palatine.

The population of Italy has now become so mixed that in many provinces it is difficult to detect and separate the original elements. But the Sardinians and the peasants of southern Italy still display the primitive Iberian type, and the Greek type survives on the sites of some of the old Greek colonies. For instance, at Naxos and Syracuse about 24 per cent. of the people have blue eyes, while at Palermo, which was never a Greek city, the proportion is less than 1 per cent. In some parts of Lombardy Teutonic village names are numerous, and Teutonic names, of Gothic or Lombard origin, are common among the nobility. Filiberto, Humberto, and Garibaldi are genuine Teutonic names; so also is that of the Italian seaman, Amerigo Vespucci, who bore the Gothic and Lombardic name of Amaric, which he has given to the new world.

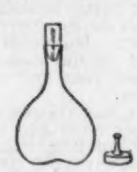
It is curious that America, the continent which has become the patrimony, shared nearly equally by the Teutonic and Latin races, should itself bear a Teutonic name, whose Latinized form bears indisputable witness to the Teutonic conquest of the oldest seat of the Latin race in Italy.

SPECIFIC GRAVITY.

To the practical pharmacist specific gravity means simply a comparison of the weight of a certain volume of some solid or liquid with the weight of an equal volume of water at standard temperature.

Dispensing pharmacists rarely have occasion to determine the specific gravity of solid substances, but the identity and quality of many liquid preparations are judged chiefly by this feature. . . . Processes for determining the specific gravity of solids can be readily found in standard text books, but every pharmacist should be thoroughly familiar with the methods and appliances for ascertaining the specific gravity of fluids.

The "specific gravity bottle" here outlined (often



called pycnometer) is considered the most accurate instrument for taking the specific gravity of liquids. It is usually made to hold exactly 1,000 grains, or sometimes 100 grammes of pure water at standard temperature, and its neck is fitted with a perforated ground glass stopper. . . . In using it, the liquid to be tested is first adjusted to the standard temperature indicated on the bottle, the bottle is filled to the lip, and the stopper carefully inserted, allowing excess of liquid and confined air to escape through the perforation in the stopper; the bottle is then dried and weighed, with counterpoise shown in cut on the opposite scale pan. . . . The weight of the liquid indicates its specific gravity at once by comparing with the weight of an equal volume of water. The 100 gramme bottle will hold 116 grammes of hydrochloric acid (sp. gr. 1·16), or 125 grammes of glycerin (sp. gr. 1·25), or 75 grammes of ether (sp. gr. 0·75), or 1,350 grammes of mercury (sp. gr. 13·50).

Archimedes proved experimentally that a body immersed in a liquid loses as much weight as its own bulk of that liquid weighs; also that when a body is placed in a liquid in which it is capable of floating, it sinks just deep enough to displace its own weight of the liquid. If a body is heavier than water, it sinks. If it is lighter than water, it floats—and this is equally applicable to other liquids. We have practical illustrations of this principle about us every day. A ship floating on the lake sinks just deep enough to displace its own weight of water. A log, which weighs heavily in the air, weighs less than nothing and consequently floats in water. Iron sinks in water but floats lightly upon mercury. A piece of wood or cork forced under water strives to reascend with a force equal to the difference between its own weight and the weight of an equal volume of water. Ice floats upon water from which it is formed, simply because water at 39° F. is more dense than ice at 32° F. And so on.

The hydrometer, which is our simple and reliable guide in ascertaining and comparing the density of liquids in practice, is based upon the above mentioned law. It sinks deeply into light liquids and floats high upon heavy liquids; the exact degree being shown upon the graduated scale.—*Bulletin of Pharmacy.*

THE CARBONIC ACID IN AIR.

DR. AUGUSTUS H. GILL has contributed to the *Journal of Analytical and Applied Chemistry* some observations upon the examination of air for carbonic acid, by the method of Pettenkofer, which consists in bringing a large known volume of the air in contact with standard barium hydrate. The bottles employed by Dr. Gill in practicing this method are ordinary green glass gallon or two gallon bottles, fitted in a partitioned basket for convenience of carriage. The bottles must be clean and dry when used for taking a sample of air; and they are closed with rubber stoppers through which passes a glass tube, closed with a rubber nipple. These stoppers have to be thoroughly digested with caustic potash, and washed. The air is drawn into the bottles by means of a fan or a pair of bellows, working as quietly as possible, so as to avoid disturbing the atmosphere. To test the sample, 50 cubic centimeters of the standard barium hydrate are run rapidly into the bottle and the interior surface is wetted with it, the contents being shaken up at intervals for an hour. The liquid is then drained off and titrated with standard sulphuric acid, using rosolic acid as an indicator. The difference between the number of cubic centimeters of standard acid required to neutralize the amount of barium hydrate before and after absorption gives the number of milligrammes of carbonic acid present in the air. By this method the air in a well-ventilated lecture room 15 feet high, having a capacity of 24,000 cubic feet, and supplied with 185,000 cubic feet of fresh air per hour from three flues, was found to increase its proportion of carbonic acid from about 4 parts to between 11 and 12 parts in 10,000, within one hour, 225 students being present. In the same way, the air of an ordinary theater was found to contain carbonic acid ranging from 39·13 parts in 10,000 on the floor to 48·94 parts in 10,000 in the gallery.

CRYSTALLIZED VEGETABLE PROTEIDS.

AN interesting paper on this subject by Thomas B. Osborne is given in the December number of the *American Chemical Journal*. We make brief abstracts.

The existence of crystallized proteids in seeds was pointed out by Hartig in 1855. Four years later, Maschke obtained hexagonal plates of proteid matter by extracting Brazil nuts with water heated to 40°-50° and evaporating the filtered extract at 40°. Nageli* investigated the crystal-like forms from the Brazil nut as well as the artificially produced crystals of Maschke, and concluded that they differed in some respects from true crystals. He therefore designated them as "crystalloids."

The writer prepared rhombohedral and octahedral crystals from the oat kernel by cooling a warm dilute sodium chloride solution saturated with the proteid.†

The writer has also obtained octahedral crystals from flax seed by extracting with a solution of sodium chloride and dialyzing the filtered extract; the proteid separating in well-formed crystals as the salts were removed.‡

The fact that these proteid substances can be artificially crystallized is not only interesting in itself, but is important as presumably furnishing a means for making preparations of undoubted purity which will afford a sure basis for further study of their properties. The contradictory statements made by the various investigators, not only in regard to properties and composition of these bodies, but also in respect to the value of the methods of solution and separation which have been employed hitherto, render an exact knowledge of all the facts relating to these substances a matter of the highest scientific and practical importance.

An examination of the literature indicates that definitely crystallized preparations from the Brazil nut have never been analyzed, and also shows that the published analyses do not agree sufficiently to fix the composition of the substance.

As the writer had already prepared crystallized products from the oat kernel and flax seed, he determined to reinvestigate the similar bodies obtainable from the Brazil nut, hemp seed, castor bean and squash seed, and the results of this investigation are embodied in the above paper.

CONCLUSIONS.

1. The data presented in this paper indicate that the crystallized globulins of the Brazil nut and of the oat kernel are distinct substances. To facilitate comparison, analyses of these two globulins are here stated as follows:

	Brazil nut. I.	Oat kernel. Average.
Carbon	52·18	52·18
Hydrogen	6·92	7·05
Nitrogen	18·30	17·99
Sulphur	1·06	0·53
Oxygen	21·54	22·34
	100·00	100·00

If the differences in nitrogen and sulphur content are not perhaps sufficient to distinguish these two proteids, their reactions prove them to be distinct, for when prepared in the same manner they are unlike in many respects.

In distilled water heated to 60° the globulin of the Brazil nut is wholly insoluble, while that of the oat kernel dissolves completely. Saturation of a 10 per cent. sodium chloride solution of these substances with salt almost completely precipitates the proteid of the oat kernel, that of the Brazil nut being unaffected. Saturation of similar solutions with magnesium sulphate precipitates but little of the Brazil nut, but all of the oat globulin. When solutions of these bodies in 10 per cent. sodium chloride brine are heated, the Brazil nut globulin begins to separate at 70°, a flocculent coagulum forming at 84°, which increases on raising the temperature to boiling, the proteid being largely but not wholly precipitated. The globulin of the oat kernel, on the other hand, is not coagulated at all by boiling.

2. The crystalline globulins of the hemp seed, castor bean, squash seed and flax seed are almost identical in composition, as may be seen by comparing the analyses:

	Hemp seed. 5.	Castor bean. 9.	Squash seed. 10.	Flax seed. Average.
Carbon	51·28	51·31	51·66	51·48
Hydrogen	6·84	6·97	6·89	6·94
Nitrogen	18·84	18·75	18·51	18·60
Sulphur	0·87	0·76	0·88	0·81
Oxygen	22·17	22·21	22·06	22·17
	100·00	100·00	100·00	100·00

The carbon content of the hemp and castor globulins is less than that of the squash and flax globulins by about 0·25 per cent., a difference too slight to have importance, if it were not constant for almost all the preparations analyzed. The deportment of these globulins toward reagents is also very similar, but in this respect the hemp and castor globulins show slight dif-

* Botanische Mittheilungen (Munchen, 1863), vol. i.

† Report Conn. Agri. Expt. Station, 1890, and this Journal, 13, 406; 14, 212.

‡ This Journal, 14, 329, 629.

ferences from those of the squash and flax seed; the two former are, however, almost exactly alike, and the two latter likewise closely agree together.

As already stated, the proteids coagulating at the lower temperature are traces of other globulins imperfectly separated from the crystalline globulin. The coagulum separating at the higher temperature is undoubtedly a part of the crystalline globulin which is broken up when heated to this temperature. It is seen that the temperature at which this coagulum separates is the same for all four substances.

In solubility these four proteids are very nearly alike, the most noticeable difference being that the globulins of the hemp seed and castor bean, when separated from a warm sodium chloride solution, are soluble in water and diluted glycerin, while the other preparations, both of the substance and the globulins of other seeds, are insoluble under the same conditions.

Of the flaxseed globulin separated from a warm salt solution, a little dissolves in water at 40°.

The small precipitate obtained by saturating a sodium chloride solution of the globulins with salt undoubtedly consists mostly of traces of other globulins.

It is at present possible to assert that these four globulins are the same, but since differences exist between different preparations of globulin from the same seed as great as those found among the globulins of these different seeds, the writer is disposed to consider these four globulins as identical.

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ANALYSIS OF WASHING POWDERS.

By W. J. KINNEY, W. H. WENGER and F. P. D.

THE various washing powders used as substitutes for soap present a conspicuous example of substances in general use which are usually employed with little understanding of their nature or composition.

The four samples selected are of such powders for washing clothes, etc., largely sold in Virginia, and a knowledge of their composition will prove of interest to many. Analysis afforded the following results:

	A.	B.	C.	D.
Sodium carbonate..	45·2	26·9	49·2	46·6
Fatty acids........	26·4	44·0	25·6	25·7
Combined soda......	3·1	3·4	3·5	2·6
Fine sand..........	...	16·3	...	...
Water..............	23·7	8·8	19·1	24·9
	98·4	99·4	97·4	99·8

A portion of this water is necessarily in the soap, and the remainder is with the sodium carbonate, which has in each case been partially dried. The soaps used do not contain resin. Not a trace of borax was present.

We may therefore describe these substances as generally composed of a mixture of soap and dried washing soda, both powdered.

While a small amount of such powders may properly be employed, in a conjunction with soap, to remove the "hardness" of the water when washing textile fabrics, yet the substitution of any such powders for soap must result in a gradual corrosion of cotton, linen or woolen goods.

Borax might be employed in place of soda in the above preparations with great advantage (to all except the manufacturer), since it has no corrosive action upon such fabrics, and, while it removes all hardness from the water, is also an excellent detergent.—*Am. Chem. Jour.*

THE LUMINOSITY OF COAL GAS FLAMES.

By Dr. JAMES LEICESTER.

DAVY, in 1818, accounted for the luminosity of flame as follows: "The luminosity of flame is due to the decomposition of part of the gas toward the interior of the flame where the air is in smallest quantity, and the deposition of solid charcoal, which, first by its ignition and then by its combustion, increases in a high degree the intensity of the light."

Prof. Smithells, in his paper on "The Structure and Chemistry of Flames," says: "Air charged with benzene vapor yields a flame in which, after the two non-luminous cones have been separated and the supply of benzene vapor increased, a luminous tip appears in the inner cone, and on further increasing the benzene this tip extends as a vertical streak of separated carbon. It is luminous for some distance above the inner cone, then cools down, and only becomes incandescent again on passing through the tip of the upper cone. The carbon which is in the solid state must either undergo the usual glowing combustion or escape from the flame unburned. As it does not do the latter to any appreciable extent it must burn, and the cessation of its combustion as a solid marks the limit of the yellow or luminous region of the flame."

Again, the higher we go in the flame the greater proportionally is the amount of separated carbon, for we have not only the heat of laterally outlying combustion to effect decomposition, but also that of the lower parts of th flame; the lower part of a luminous flame is accordingly cooler, and contains less separated carbon than the upper.

Prof. Stokes has shown the separation of carbon or carbon associated with hydrogen in flames by its polarizing effect on light.

Prof. Vivian B. Lewes lays great importance upon the acetylene formed. He says: "The luminous zone, in which the temperature ranges from 1,100° to a little over 1,300°; here the acetylene formed in the inner zone becomes decomposed by heat with liberation of carbon, which at the moment of separation is heated to incandescence by its own combustion and by the combustion of carbon monoxide and hydrogen, and gives luminosity to the flame. He has shown that oxidation, dilution, and cooling all help to bring about the destruction of luminosity in a Bunsen flame. In other words, the liberation of free carbon is reduced, and therefore the luminosity is diminished.

The various reasons here given refer entirely to the carbon particles being burnt or raised to incandescence by the heat of combustion of other constituents. It has occurred to me that possibly a portion of the luminosity might be due to the nascent carbon particles having the power of occluding certain of the gases, and thus being raised by the heat of condensation to incandescence.

As the further study of flames ought to be left to Prof. Smithells, I simply lay the suggestion before those chemists who are interested in the subject, and have communicated with him.—*Chem. News.*

OXIDATION OF NICKEL CARBONYL.

IF nickel carbonyl is kept in an ordinary bottle with a ground glass stopper, a layer of light green hydrate is formed on the top, while some of the carbonyl escapes as a vapor between the stopper and the bottle and is deposited on surrounding objects. M. Berthelot has chemically examined this product of decomposition, and states in the *Bulletin* of the French Chemical Society, as a result of his researches, that it appears to be a hydrated oxide of an organo-metallic compound of nickel having a composition corresponding to the formula, $C_8 O_3 Ni_5 . 10 H_2 O$. It therefore appears to be the oxide of a complex radical analogous to croconic and rhodizonic acids. While spread in a thin film this compound is white, but when viewed in mass it has a greenish tinge.

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